OHEC
375.00971
059DE10
V.27

ONTARIO COLLEGE OF EDUCATION

Ontario College of Education
Library
JUL 9 1951
University of Toronto

ONTARIO
Department of Education

SUGGESTIONS FOR TEACHING AGRICULTURE IN ELEMENTARY SCHOOLS

Issued by Authority of
The Minister of Education
COPYRIGHT, CANADA, 1945

ONTARIO
Department of Education

SUGGESTIONS
FOR
TEACHING
AGRICULTURE
IN
ELEMENTARY SCHOOLS

Issued by Authority of
The Minister of Education
COPYRIGHT, CANADA, 1945

75165
WITHDRAWN

TABLE OF CONTENTS

Introduction.......... 5

General Objectives of Agricultural Instruction 6

Section One—Soil and Soil Problems.......... 7

Section Two—Plant Studies.......... 27

Section Three—Live Stock.......... 39

Section Four—Milk.......... 57

Section Five—Poultry Keeping.......... 69

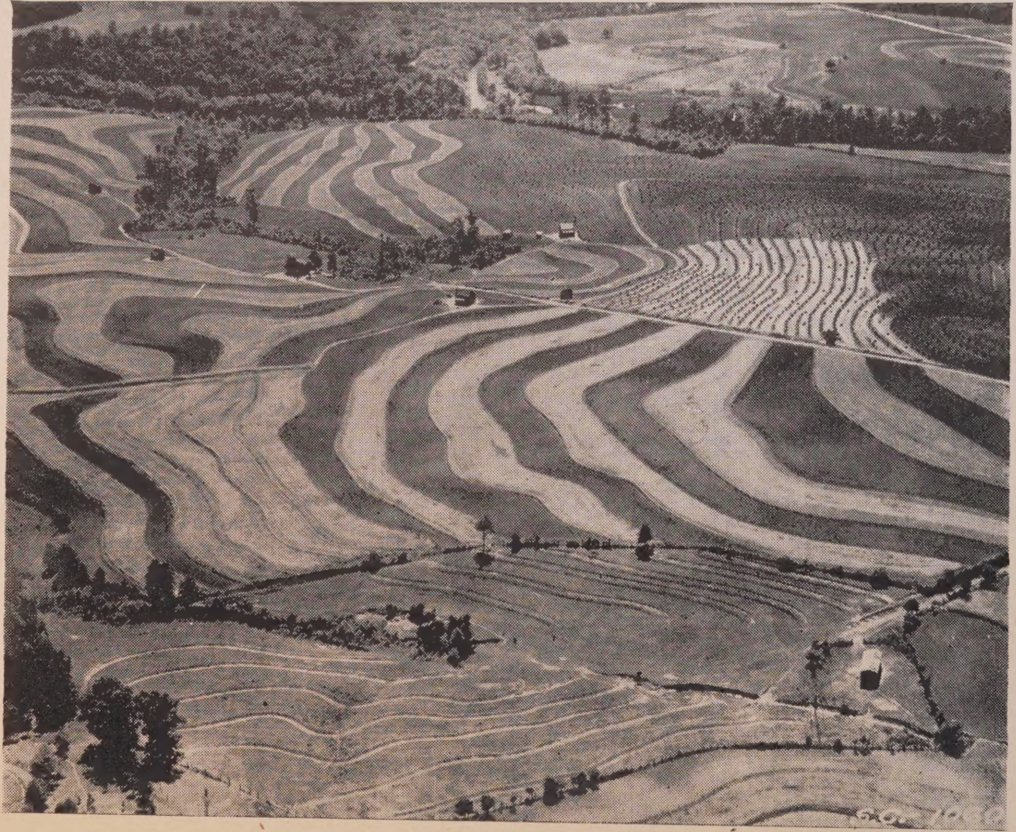
Section Six—Gardening.......... 91

Section Seven—Plant Diseases..........115

Appendix A—Panel Discussion Method..........126

Appendix B—Apparatus and Materials..........133

Index..........134



(*Permission, Farmer's Advocate*)

Fig. 1. Contour cropping helps to prevent erosion on slopes.

INTRODUCTION

The art of agriculture had its beginning in ancient times, when people first began to take an interest in the production of plants or the care of animals to meet their needs. This marked the beginning of civilization since it permitted man to change from the uncertain existence of the hunter to a more settled life, in which social organization could develop. Progress was slow for many centuries until better implements for cultivating the soil were invented and the principles of breeding live stock for improvement came to be understood

Some two hundred years ago science and invention came to the aid of agriculture and soon made it a science as well as an art. Today it is a combination of art, science and business. Improvement in methods of production and marketing is an important feature in the development of modern agriculture.

Human welfare in our social order depends fundamentally on the study and practice of underlying principles of tilling the soil and conserving it, of cultivating and improving crops, of breeding and rearing live stock in the most economical way, and of beautifying home and school surroundings. Progress is only possible when such basic factors as these are understood and appreciated. It is only as agriculture advances that the human race advances.

A few of the great improvements in agriculture were effected by the invention of mechanical contrivances to meet real needs. The iron plough was among the first. It was followed by the sulky plough and the two-bottom (gang) plough pulled by four horses. Now the disc plough has come into use. As soon as the gasoline engine could be made small enough, the tractor was developed as a source of farm power to take the place of horses. As harvesting devices, the hand sickle was superseded by the scythe and the cradle. Then followed the invention of the McCormick reaper in 1831. (It is interesting to note that it was ten years before the inventor found a buyer.) The self-binder soon superseded the reaper, and today we have the two-man combined harvester and thresher.

There have been many improvements in dairying. The milking machine has on many farms replaced the old tedious method of milking by hand, just as the cream separator has taken the place of the old shallow pan in which the cream was skimmed from the milk. The Babcock test is used to determine the percentage of fat in milk; it provides both a fair basis for payment for milk and, considered along with weight records, determines the value of any cow as a producer. The process of pasteurization is used to make milk and its products safe for human consumption. Electricity for lighting and for operating many farm and household machines has done a great deal to reduce the drudgery and manual labour in the dairy and elsewhere.

Today there are several types or kinds of farming while a hundred years ago general farming was practised by nearly all tillers of the soil. Man, however, has learned that success depends largely on the kind of soil, the climate and the market as well as on skill and industry. Consequently, today one sees some sections of the country devoted to specialization in dairying and in raising live stock, others to fruit growing, others to tobacco farming, and others to poultry farming. Specializing gives man an opportunity to choose the kind of farming which attracts him. General or mixed farming, however, over a period of years, is regarded as the safest practice. The type of farming in our Canadian West is gradually shifting from grain growing to mixed farming.

Farming should be a mode of life which provides both interest and satisfaction. Being away from the crowd and the noise of city life appeals to many. In country life they find opportunities to reflect, plan and create. Caring for live stock and cultivating field, orchard and garden crops affords a real understanding and appreciation of Nature. These are some of the reasons why many people brought up in rural communities have developed fine traits of character and shown outstanding ability.

The interdependence of country and city life is not understood and appreciated by many. The teaching of agriculture in our schools is needed to bring about a better relationship between the two. The development of a new and better social order depends on this. The farmer produces the basic products to maintain city life and for these he deserves a fair market price, so that he may buy in the city or town what he needs for a satisfactory life. In pioneer days agriculture was self-sufficient, but today is closely associated with other industries and business; consequently it has become specialized. Good roads, the automobile, daily mail, and the radio are bringing country people and city people into closer association. Country boys and girls in increasing numbers go to the high schools in our towns and cities and there associate with those who are used to an urban mode of life. The farmer needs the city and town to consume his marketable products, to provide him with a banking system, to print his newspaper, to provide manufactured goods of all sorts, and to render professional services of all kinds. Neither country life nor city life can do without the other. The best co-operation and goodwill between the two are necessary for human welfare.

GENERAL OBJECTIVES OF AGRICULTURAL INSTRUCTION

1. To stimulate interest in agriculture as Canada's basic industry, and to recognize the contribution it makes to human welfare.
2. To show that the problems of agriculture challenge real ability as much as those of any other vocation.
3. To engender a real appreciation of country life.
4. To meet the needs, capacities and interests of pupils of Grades VII and VIII for acquiring knowledge and developing skills along agricultural lines.
5. To integrate agriculture with other school activities and with life out of school.
6. To give training in careful observation and intelligent interpretation of facts and principles, and their application through purposeful activities and enterprises.
7. To develop the habit of relating cause and effect and of drawing conclusions from first-hand experiences.
8. To cultivate initiative, resourcefulness and co-operation in solving practical problems.
9. To develop skill in procedures similar to those practised on the farm.
10. To train students in the proper use of books, agricultural bulletins and other sources of information.

Section One . . . Soil and Soil Problems

Composition and Formation of Soils
- Soil Particles
- Particles in a Garden Soil
- Types of Soil
- Depth of Soil and Subsoil
- Makers of Soil
- Classification of Soils by Position

Water and Air in Soil
- Position of Water and Air in Soil
- The Water-holding Capacity of Soils
- Behaviour of Capillary Water
- Importance of Drainage

Maintaining Soil Fertility
- Important Nutrients Taken Out of Soil by Cropping
- Farm Manure
- Green Manure
- Fertilizers
- Crop Rotation
- Soil Acidity
- Soil Bacteria

SECTION ONE
SOIL AND SOIL PROBLEMS

Approach: Throughout the ages soil has been the storehouse in which are hidden the treasures of life. The ancients called soil "our mother"; and rightly so, for it has been a provident mother to all mankind. The crops from it have provided food, clothing and shelter. To secure these necessities, however, farmers and gardeners had to solve various problems pertaining to the nature of their soil, its drainage, fertility and tillage. Today, more than ever, we need knowledge and skill to harvest its treasures and, at the same time, to prevent its becoming worn out and exhausted.

I

COMPOSITION AND FORMATION OF SOILS

Important things to think about:

1. The nature of different soil particles.
2. How to find what constitutes a good soil.
3. The relationship of soil and subsoil.
4. The characteristics of different soils.
5. Where the soil came from.

SOIL PARTICLES

Soils do not look alike because the particles they contain vary in size and kind of materials. How can the differences be determined?

Problem 1: Closely examine sand, clay and muck to find the nature of their particles.

Method: Examine a small quantity of each by rubbing it between the fingers and thumb and by looking at it through a hand lens. Record how their particles differ in respect to *sharpness*, *hardness*, *size*, *shape* and *colour*. Compare the appearance of the particles found in the sand with chunks of quartz and feldspar and pieces of mica. Note the relative quantity of dark material in each soil.

Explanation: Common sand is largely composed of broken-down quartz, feldspar and mica; the very fine clay particles, which felt smooth when rubbed between the fingers, are largely composed of powdered limestone, shale and feldspar. This broken-down rocky material is classed as *mineral matter* of soils. The muck was found to be dark, soft and spongy, and to contain some fibre. It was formed chiefly from decayed material from leaves, wood, roots, grass or animals. These materials are called *organic matter*. Some organic matter is found in all productive soil.

PARTICLES IN A GARDEN SOIL

Examine a loamy garden soil. What does it seem to contain?

Problem 2: To find the kind of particles in a garden soil by separating them.

Method: Half fill a tall jar or large test tube with water and add half as much garden soil. Cover the container and shake up the contents thoroughly. Set it aside for a few hours and then observe what has happened. Identify the layers.

Conclusions: What does the garden soil contain? Which particles are the heaviest? Which are the lightest? Make a labelled diagram of the jar showing the arrangement of the layers. Explain why the particles of the loam separated into layers of sand, clay and muck or humus.

Questions and Exercises:

1. In a hilly field, why is the soil darker in the valley than on the hilltop?
2. On flats, along creeks and rivers, the soil is often found in layers near the stream and the pebbles and stones in the swift running water. Explain what brought this about.
3. Read *Canadian Agriculture for High Schools*, pp. 278–9.

TYPES OF SOIL

Nature has made different types of soil. These are classified according to the predominating size of particles which the soil appears to contain.

Problem 3: Examine different types of soil so that you may be able to identify them.

Method: Collect and label samples of sandy soil, sandy loam, clay loam, clay, gravelly loam and muck soil. Examine each and note the kind of soil particles which appear to predominate. Record your conclusion in the following table.

TYPE	CLAY	SILT	SAND	STONES	HUMUS
Clay soil........	....	....	....	....	....
Clay loam........	....	....	....	....	....
Sandy loam........	....	....	....	....	....
Sandy soil........	....	....	....	....	....
Gravelly soil........	....	....	....	....	....
Muck soil........	....	....	....	....	....

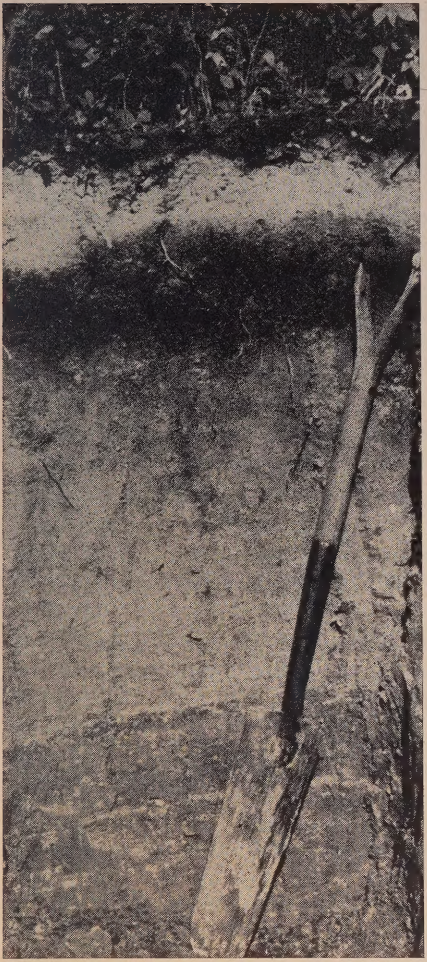
Which soil has the most clay particles? What does the clay loam appear to contain? How could you find out which soils are sticky when wet?

Conclusions: Coarse-grained soils, sandy and sandy loam, are commonly called *light soils* because they are somewhat loose in texture and are easy to cultivate. Are they sticky when wet? The fine-grained soils, clay and clay loams, are called *heavy soils* because they are compact and hard when dry, sticky when wet, and hard to cultivate. From the standpoint of weight, however, a cubic foot of dry 'light' soil is heavier than a cubic foot of dry 'heavy' soil. To verify this, weigh a quart jar of clay and one of sand.

Questions and Exercises:

1. Determine the type of soil on your home farm or in your home garden. Is it light or heavy soil?
2. What kind of soil is best for general gardening, light or heavy? Why?
3. How could you find out the approximate amount of humus in a soil by using the experiment of Problem 2?

DEPTH OF SOIL AND SUBSOIL



(*Photo by G. A. Hills*)

Fig. 2. A soil profile.

Common types of soil in which crops are produced can now be identified.

Problem 4: Compare the surface soil with the subsoil.

Method: Discuss the appearance of profiles of gravel pits, sand pits, ditches or foundations dug out for houses. How is soil distinguished from subsoil? Are all subsoils alike? Is there solid rock at the surface in the locality? Are there any wells in the vicinity that reach solid rock? At what depth?

Findings: The term soil usually refers to the top eight to fifteen inches in which most crops are planted. This cultivated layer contains varying amounts of humus. The term subsoil is applied to that compact layer directly below the soil. Its depth varies from a few inches to four or five feet. A vertical section through the soil and subsoil is known as a soil profile.

Questions and Exercises:

1. Distinguish between soil, subsoil and bed rock.
2. Enumerate useful things man makes out of certain kinds of subsoil.
3. Read *Canadian Agriculture for High Schools*, pp. 279–283.

MAKERS OF SOIL

It is interesting to know how the different kinds of soil and subsoil came to their present position on the bed rock. They were made by soil-forming agents which have been at work for ages.

Problem 5: How were soils made?

Method: Discussion of the following agencies:

1. *Glaciers.* Canada's soil is principally of glacial origin. During the glacial period of long ago great ice sheets. perhaps more than a mile thick,

spread southward over Canada from northern areas, where they had accumulated. As they slid over the uneven bed rock with tremendous pressure, enormous quantities of rock were broken down and ground into soil materials which were transported as the ice moved along. This process went on for a long period of time. Then the climate gradually became warmer and the glaciers melted and deposited this subsoil material on the bed rock. The streams formed by the melting ice carried much of this pulverized material away from the front of the glaciers. Since that time, weathering agents have been at work bringing about further disintegration and decomposition. In some mountainous regions glaciation is still going on and boulders and pulverized rock materials are being forced to lower levels where other weathering agents further reduce the materials to soil.

2. *Water.* Recall examples of the mechanical action of running water on hillsides, in rivers, and also that of waves along lake shores. The abrasive work causes boulders, stones and pebbles to be worn smooth and round, quite in contrast to quarried or crushed stone. The ground-up product of these pulverizing agencies is soil material.

What has caused the formation of gullies and canyons? Explain the formation of deltas and plains of alluvial soil.

3. *Wind.* Examine and discuss pictures of sand dunes. These dunes were caused by the carrying power of wind. Wind storms, carrying dust and sand, give further evidence of the cutting and carrying power of moving air. The particles strike cliffs, buildings and fences and gradually disintegrate them to form soil materials.

In what kind of regions are winds and water most destructive to productive soils? It has been found that in rolling and sandy regions where nearly all the forests have been removed because of a desire to bring land under cultivation, both winds and water are most destructive. A practical method of overcoming this condition is to avoid fall ploughing on very rolling fields, or fields that have a decided slope. If these fields are ploughed up and down the slope—a mistake that is sometimes made—the maximum amount of washing from rain and melting snows, and a considerable removal of both minerals and organic matter by wind, may occur. When such fields must be ploughed in the fall, ploughing should be done early, and across the slope rather than up and down (see frontispiece). Then the fields should be harrowed and seeded with fall rye or winter wheat. The autumn growth will hold the soil in place and prevent washing out of both soluble nutrients and small soil particles. On sandy land the growing crop will prevent erosion by the wind during dry weather. Very sandy areas should be reforested.

4. *Temperature Changes.* Recall examples of the expansion of solids by heat, and their contraction on cooling. Apply this to the changes in the temperature of rocks by day and night. The resultant expansion or contraction may develop sufficient force to produce cracking and splintering. Illustrate this by heating a glass bottle. What happens?

Recall the effect when a bottle of water or ink is left outside during a very cold day. This illustrates what happens when water freezes in the crevices of rocks. Discuss how a farmer sometimes disintegrates a huge boulder which he wishes to remove from his field. Explain how alternate freezing and thawing improve the physical condition of clayey soils. Why should such land be ploughed in the fall?

5. *Plants and Animals.* Mosses, lichens and algae are plants which help to break up the rocks on which they grow; they promote the decay of trees, fallen logs or fence rails on which they are frequently seen; they may also slowly catch dust, clay and silt carried by the wind; when they decay, humus is formed. The roots of trees on rocky areas penetrate the crevices and as they grow they pry the rocks apart and break off pieces. Recall the burrowing and feeding habits of earthworms. Much of the soil they consume is brought to the surface as castings. Their burrowing activities and those of ants, groundhogs, gophers and other animals cause better circulation of air and water. Contact with air and water brings about changes in the soil and subsoil. The farmer, too, works to bring about changes in the soil. He drains and ploughs the land, adds stable manure, green manure, fertilizers and lime, all of which in some degree change the physical and chemical composition of the soil to make it more productive.

6. *Soil Bacteria.* These are microscopic plants which are continually at work in surface soil changing organic matter such as dead plants and animals into humus, or bringing about other chemical changes. They need warmth, moisture and darkness to thrive.

7. *Oxidation.* This is caused by the air coming in contact with certain moist mineral matter of the soil. Compare the process with the rusting of iron which changes the metal to a reddish rust. Some rock materials contain iron and, when oxidized, the affected masses change colour and show a tendency to crumble. This is a common chemical process.

8. *Action of Carbon Dioxide.* Recall that air contains carbon dioxide which is given off in the breath of animals, by decaying plant material, and by fires.

Experiment: Prepare carbon dioxide by the action of hydrochloric acid on chips of limestone or marble in a flask fitted with a delivery tube. Bubble the gas through water in a large test tube. Test the solution in the tube with blue litmus paper. If it slowly turns red, you have succeeded in making carbonic acid.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

In a similar way rain or melted snow waters combine with carbon dioxide in the air or in the soil and form carbonic acid. This substance helps to dissolve some rock materials, particularly limestone.

9. *Hydration.* Why are some soils red and others yellow? The red colour is usually due to the presence of a mineral called hematite or red oxide of iron in the disintegrated rock. Water may combine with the hematite to form a mineral called limonite or yellow oxide of iron. This process of combining with water is known as hydration.

CLASSIFICATION OF SOILS BY POSITION

From the standpoint of the way soils were formed, those which have been moved from their place of origin by such agents as gravity, water or wind are classified as *transported soils;* and those which remained where they were formed are classed as *sedentary soils.*

Questions and Exercises:

1. Enumerate (a) Mechanical agents, (b) Chemical agents that have played a part in making soil.
2. Name the two general classes of soils (a) by texture, (b) by position, and distinguish between them.
3. Explain how humus or organic matter came to be mixed with the mineral matter from the rocks to form productive soil.
4. What causes the difference in the colour and texture of soils on hillsides and in valleys?
5. How could you show that rapid changes in temperature disintegrate rocks?
6. What are the sources of sand, clay and humus in soils?
7. Read *Canadian Agriculture for High Schools*, pp. 257–267.

II

WATER AND AIR IN SOIL

In addition to mineral and organic matter, soils also contain water and air. Both are needed to grow good crops. In this connection there are a number of problems which are worth considering.

1. The position of the water and air in the soil.
2. The kinds of water in soils.
3. How to show the presence of air in soil.
4. Whether all soils have the same capacity to hold water.
5. Whether the quantity of water affects the growth of plants.
6. Why should potted plants not be watered too often?
7. How do plants get water during dry weather?

POSITION OF WATER AND AIR IN SOIL

Problem 6: Both water and air are necessary in soil to make it productive. Where are water and air held in the structure of soil?

Method: (a) Partly fill a wide-mouthed bottle with dry pebbles. Can you see spaces between the pebbles? What is in these spaces? Add enough water to cover the pebbles. Where did the water go? What did it force out from between the pebbles? Now cover the mouth of the bottle with your fingers and turn the bottle upside down permitting all the free water to drain off. Then observe the surface of the pebbles. Did all the water run off? The water which drained off is called gravitational or *free water*, and the layer of water held by the pebbles is called *film water*.

(b) Fill a test tube one-third full of dry soil. Add enough water to nearly fill the tube, and watch for bubbles of gas rising through the water. This is *soil-air* which the water forced out. Now turn the test-tube nearly upside down to permit only water to run out. What water escaped? What water was held? What now fills the space which was occupied by the gravitational water?

(c) How much capillary or pore space is there in a loamy soil? Gently pack a 100 ml.* measuring glass with well-powdered dry loam up to the 50 ml. mark. Put 100 ml. of water into another measuring glass and gradually pour some of it onto the 50 ml. of soil until all the pore spaces are full of water. The soil and the water are now at the same level. Record the result:

Volume of soil used..
Volume of water added...
Percentage of pore space in the soil...........................

THE WATER-HOLDING CAPACITY OF SOILS

Problem 7: Compare the water-holding capacity of sandy soil, clayey soil, loamy soil.

Method: Use three lamp chimneys of the same size and cover one end of each with cloth held in place by string or an elastic band. In the first chimney, place powdered dry clayey soil; in the second, dry sandy soil; and in the third, dry loamy soil. Pack these materials gently so that each chimney is just half full.

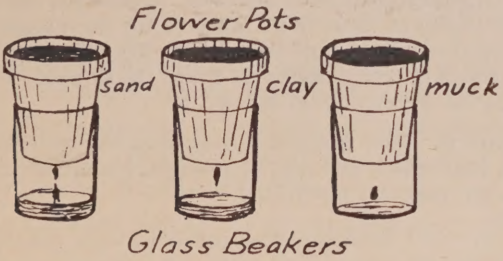


Fig. 3. An alternative method of measuring water capacity of soils.

Support each chimney over an empty beaker, and pour 300 ml. of water onto each kind of soil. Catch any water that leaches through and, after dripping has ceased, measure this water and calculate the quantity of water held by each kind of soil. Observe the colour of the water which leached through the soil. Record all your results.

Soils	Water Added	Free Water	Water Held
Loam..................................	300 ml.	....	....
Clayey soil........................	300 ml.	....	....
Sandy soil.........................	300 ml.	....	....

---

*One millilitre (ml.) is equal to one cubic centimetre (cu. cm. or cc.).

Conclusion: Which soil holds the most water? Which the least?

Questions:

1. Which type of soil would dry out quickest? Why?
2. Does gravitational water dissolve anything as it leaches through the soil? How do you know?
3. Does the film water held by the particles of soil contain dissolved materials in solution? Explain.
4. What is meant by the water-holding capacity of a soil?
5. How can the water-holding capacity of a sandy soil be increased to make it more productive?

BEHAVIOUR OF CAPILLARY WATER

Why can a potted plant be watered by setting it in a shallow dish of water?

Problem 8: To find how water moves in dry soils.

Method: Take three lamp chimneys and cover the small end of each with a piece of cloth. Then fill one with dry sandy soil, another with powdered dry clay, and the third with powdered dry loam. Put in the material a little at a time, and pack it gently after each addition. Stand the chimneys in a tray having about two inches of water in it. Observe the movement of water, called capillary water, up through the pore space of the dry soil. In which soil was the capillary movement of water quickest? In which the slowest? Now explain why potted plants can be watered from below.

In the experiment under Problem 7, regarding the water-holding capacity of different soils, that which was held is also called capillary or film water. It clung tightly to the particles of the soil.

Explanation: In dry soil wherever the particles were touching, film water moved up and around the adjacent particles until the water reached the top of the soil. The passages through which it moves are hairlike and are called capillary tubes, derived from the Latin word "capillus," a hair. The smaller the passages, the higher the water will rise. (This is also the way oil moves up through a lamp wick.) As the water moves upward, it dissolves soluble materials in the soil, and when it comes to the roots of growing plants, some of the water and dissolved materials enter the root hairs. Having entered the roots, it moves up through the stem to the leaves. The dissolved material constitutes part of the food of the plant. The water helps both in the manufacture of food in the leaves, and in its distribution through the plant.

Notice that the movement of capillary water in dry soil may be upward against the force of gravity, and that the movement of free water in wet soil is downward owing to the force of gravity. The capillary or film water is held because the force of adhesion between the film water and the soil particles is greater than the force of gravity on it. Nearly 40 per cent of the weight of well-drained clay in a field is capillary water. The proportion of water in a sandy soil is much less because the particles are larger and farther apart. During dry weather, where does the capillary water come from? When soil is dry and it rains, or water is poured on it, which way does capillary water move? In general, capillary water moves in any direction from wet soil to moist or dry soil.

IMPORTANCE OF DRAINAGE

One of the most important things man has learned about soil is how to control the water in it. When excess water is removed by furrows or ditches the method is known as surface drainage. When tiles are placed at varying depths below the surface the terms tile drainage or under drainage are used.

Problem 9: Does drainage promote the growth and health of plants?

Method: (a) Place two similar healthy potted geranium plants side by side. Stand one on a dry saucer, but place the other in a dish of water. Keep the dish under the one plant filled with water; to the other add, in the usual way, just enough water to keep the soil moist. In two or three weeks compare the health and growth of the two plants. Record the observations.

(b) Plant corn or beans in two prepared flower pots. Keep one standing in water as in (a), and keep the soil of the other moist by adding sufficient water from the top. Set a thermometer two inches into the soil of each pot and note the difference in temperature from time to time. Observe the difference in the growth of the corn in the two pots. Empty both and compare the wetness of the soil and the depth of the root growth. Record the observations.

Conclusions: Why did the excess water retard the growth and health of the plants? Would the removal of air or soluble materials from the soil by excess water have any effect?

Questions and Exercises:

1. When a wet field is drained what name is applied to the water removed? What name is applied to the water held by the soil particles?
2. Explain the importance of drainage for plant growth.
3. Plan an experiment, different from those described above, to show capillary action. Explain why it works.
4. After a rain, what part of the soil dries out first? What action will then be set up in the soil and subsoil?
5. How can the evaporation of capillary water from the surface of the land be checked?
6. Read *Canadian Agriculture for High Schools*, pp. 284–290.

III

MAINTAINING SOIL FERTILITY

Soils need capillary water and air to produce healthy vigorous plants. There are also other requirements. Every crop removes certain soluble materials from the soil. These are the minerals needed by the plant to develop its roots, leaves, stems and fruit or seed. The requirements of different plants vary widely. The chemical elements needed by nearly all plants are: nitrogen, phosphorus, potassium, calcium, iron, sulphur, magnesium, hydrogen, oxygen and carbon. The first seven come from the mineral matter in the soil, and constant cropping soon exhausts the supply of the first three of these. Consequently, it is a problem for the farmer and gardener to keep these replenished.

The following table was compiled from up-to-date sources to show the quantities of nitrogen, phosphorus and potassium* certain crops remove from the soil. In each case the crop was reduced to ashes which the chemist analyzed to find the quantities of each substance listed in the table.

Note which crop was the heaviest "feeder" on each of the three substances commonly applied as fertilizers.

What should be done to restore these substances to the soil in order that it may not become worn out?

IMPORTANT NUTRIENTS TAKEN OUT OF SOIL BY CROPPING

Crop	Yield per Acre	Nitrogen (pounds)	Phosphoric Acid (pounds)	Potash (pounds)	Total
Wheat	Grain 30 bu.	35	16	9	60
	Straw 1.25 tons	15	4	21	40
	Total	50	20	30	100
Oats	Grain 50 bu.	35	15	10	60
	Straw 1.25 tons	15	5	35	55
	Total	50	20	45	115
Barley	Grain 40 bu.	35	15	10	60
	Straw 1 ton	15	5	30	50
	Total	50	20	40	110
Corn	Grain 60 bu.	57	23	15	95
	Stalks 2 tons	38	12	55	105
	Total	95	35	70	200
Timothy	1.5 tons	40	15	45	100
Alfalfa	3 tons	140	35	135	310
Sweet clover	5 tons	185	45	165	395
Red clover	2 tons	80	20	70	170
Soy beans	Grain 25 bu.	110	35	40	185
	Straw 1.25 tons	15	5	20	40
	Total	125	40	60	225
Potatoes	Tubers 300 bu.	65	25	115	205
	Tops	60	10	55	125
	Total	125	35	170	330
Sugar beets	Roots 15 tons	55	22	53	130
	Tops	60	23	92	175
	Total	115	45	145	305

---

*The contents of fertilizers are usually stated in terms of the available amounts of phosphoric acid (P_2O_5) and potash (K_2O) rather than the proportions of the elements phosphorus and potassium contained in them.

FARM MANURE

What use is generally made of manure? How is it applied?

Problem 10: Why does the application of farm manure improve the soil?

Method: Consider the following table to find the quantity of fertilizer constituents in the stable manure of different classes of animals.

Table Compiled from Dominion Publication 585, 1940

ANIMAL	POUNDS PER TON IN STABLE MANURE		
	NITROGEN	PHOSPHORIC ACID	POTASH
Horse	13.15	4.35	11.55
Cow	11.44	2.82	9.75
Pig	11.15	6.13	9.03
Sheep	18.06	6.63	19.10
Poultry	19.50	15.35	8.20

In addition to these fertilizer constituents, manure supplies organic matter which improves the texture and water-holding capacity of the soil because it changes to humus.

Some of the useful ingredients of stable manure are lost under certain conditions. If the manure pile is left exposed to rain or melting snow, soluble substances may be leached out and soak into the ground near the pile. When manure heats or ferments, part of the nitrogen content is driven out by the heat in the form of ammonia gas.

Questions:

1. What essential substances do these manures supply to the land?
2. How does the richness of horse and sheep manures compare with that of cow and swine manures?
3. Why does adding manure to soil increase its water-holding capacity? Why does it improve the texture of the soil?
4. How does it tend to prevent erosion?
5. How is manure applied to the soil in your community?
6. Why is fresh manure from the stable of greater value than (a) heated or fermented manure, (b) long-standing or weathered manure?

GREEN MANURE

Sometimes farmers, instead of applying manure to their land, grow and plough under certain green crops. This practice is called green manuring.

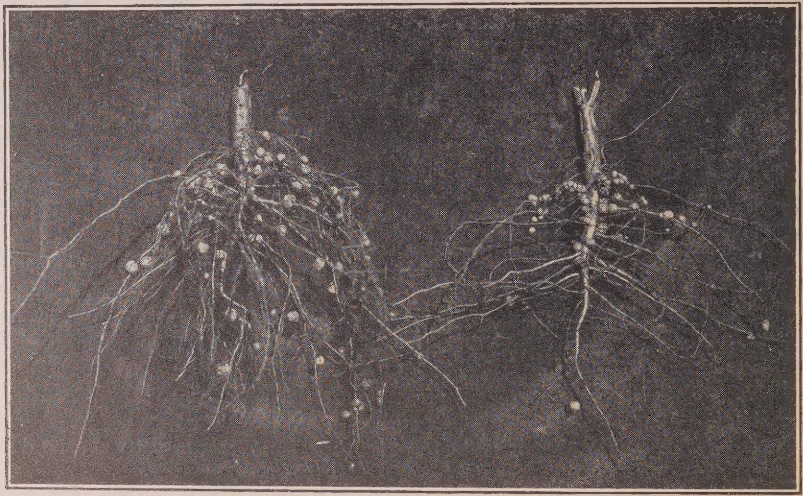
Problem 11: What green crops have you seen plowed under as green manure? How does this practice improve the soil?

Method: (a) Discuss observations of the pupils, and classify the crops ploughed down under the headings—*legumes* and *non-legumes*.

(b) Discuss benefits of green manuring for coarse soil; for fine clay soil. Emphasize its value as a means of increasing humus for fertility and for checking soil erosion.

(c) Explain why legumes are better for supplying nitrogen to the soil than are non-legumes.

Explanation: Ploughing under a green crop such as clover, alfalfa, rye, rape or buckwheat before it matures is one of the best means of building up worn-out soil. This practice adds organic matter to soil, which improves its texture and water-holding capacity; and all the mineral matter the green crop took from the soil is returned to it in a more available form. If legumes like clover, alfalfa, soy beans, hairy vetch, are used, there is the further advantage that by the action of nitrogen-fixing bacteria found in nodules on their roots, they take nitrogen from the air and add it to the soil in a form that may be used by other plants. Moreover, because they are deep-rooted plants they bring up some mineral matter from the subsoil to build up their tissues. When the green crop decays, it becomes a part of the soil which increases fertility, improves the texture and aids in preventing soil erosion.



(*Ontario Dept. of Agriculture*)

Fig. 4. Nodules on roots of soy beans.

FERTILIZERS

Various kinds of fertilizers are used to increase crop production. Find out what kinds are used in your locality.

Problem 12: What do fertilizers contain, and how do they benefit plant growth?

Method: (a) Examine a few of the following commercial fertilizers and note what they contain:

NAME	NITROGEN	PHOSPHORUS	POTASSIUM
Ammonium sulphate	20.0%	....	....
Sodium nitrate	16.5%	....	....
Bone meal	4–5%	20–29%	....
Superphosphate	....	20%	....
Potassium chloride	....	....	52%
Potassium sulphate	....	....	50%
Wood ashes	....	....	5–6%

A "complete" fertilizer is one which contains all three essential ingredients. It is usually sold with an indication on the container of the amounts of nitrogen, phosphoric acid and potash available in it. A fertilizer which is described as 3–10–5 contains 3 per cent nitrogen, 10 per cent phosphoric acid and 5 per cent potash. The remainder is a filler which has no value as fertilizer but is useful in spreading the materials over a larger area.

(b) With test tubes and water find how readily the fertilizers examined dissolve in water. Test the solutions with blue and with red litmus paper. If red litmus turns blue the solution is alkaline; if the blue turns red an acid condition is indicated.

(c) Review the essential elements needed in a soil for crop production. Of these, nitrogen, phosphorus and potassium, but especially nitrogen, are the ones likely to be deficient in worn-out soils. Barnyard manure will replenish them, and to some extent green manuring is helpful. Then why is there need for the use of fertilizers? What should be known about the soil before deciding what fertilizer to apply in order that there may be no waste?

(d) Compare the effects of several fertilizers by carrying out an experiment. Fill five six-inch flower pots with poor sandy soil or sand, and number them 1–5. Mix into the top two or three inches of each, 10 grams of a fertilizer —No. 1 sodium nitrate, No. 2 superphosphate, No. 3 potassium sulphate, No. 4 a complete fertilizer. Leave No. 5 without any fertilizer, as a control. Add water to each. Germinate wheat seeds and plant five of them an inch deep in each pot. Set all the pots in a favourable place for growth and add the same amount of water to each every few days to keep the soil moist. After the plants are up, compare their vigour and colour from time to time. After six weeks dig up plants from each pot to compare the root system. Summarize the results of the experiment.

Explanation: Since nitrate fertilizers promote stem and leaf growth and improve the colour and health of leaves, they are commonly added to soil for growing lettuce, spinach, celery, cabbage, and hay and pasture crops. The phosphate fertilizers encourage the development of the root system, cause the formation of plump kernels and hasten maturity. Consequently, they are used in growing corn, grain and legumes. The potash fertilizers improve the health of plants and increase resistance to plant diseases. Since they also promote the development of sugar and starch, they are useful in growing potatoes, sugar beets and wheat.

As a general rule, ammonium sulphate and sodium nitrate should not be added to soil where barnyard manure has been applied.

CROP ROTATION

Crop rotation is another very important aid in maintaining soil productivity.

Problem 13: How does crop rotation help to keep soil from wearing out and aid crop production? By this we mean growing different kinds of crops in successive years. A common rotation is grain seeded with clover, followed by a hay crop, and after that a hoed crop. The rotation may require more than three years.

Method: Discuss the following phases of the problem:

(a) What is meant by crop rotation? Give examples.

(b) Why does the system mean a more balanced removal of plant-food elements from the soil? (Refer to table p. 18.)

(c) What crops in a rotation will add nitrogen to the soil? Which will add organic matter?

(d) Explain how crop rotation may keep under control certain insect pests, plant diseases, and weeds.

(e) Which crops check soil erosion and soil drifting? Explain.

(f) How does the practice of crop rotation help to distribute the work of the farmer and the gardener?

Assignment: 1. Classify the crops grown in the locality under the headings: cleaning crops, feeding or fodder crops, improvement crops, cash crops.

2. Read *Agriculture for High Schools* by Andrews, pp. 27–28; 35–43.

SOIL ACIDITY

Sometimes soils yield poor crops because they are acid. This condition needs correction.

Problem 14: How can acidity of a soil be tested and corrected?

Method: (a) Put a strip of blue litmus paper and one of red litmus on the bottom of a clean beaker. If the soil is dry, moisten the sample to be tested with distilled or rain water and cover the paper in the beaker with the moistened soil to a depth of two or three inches. Add more distilled water, or rain water, to make the soil thoroughly wet and set it aside for five minutes.

Observe the colour of the litmus papers through the bottom of the beaker. If the blue turned red or pink, the soil is *acid*. If the red turned blue, it is *alkaline*. If there is no change, the soil is *neutral*.

If the soil proved to be acid or sour, mix a little lime with it and repeat the experiment using red litmus. What change took place?

(b) A better method of testing is by the use of the Reactosoil test. Secure a tube of the Reactosoil materials from the Chemistry Department, O.A.C., Guelph, for 25c. Directions are given with it for making the test, and the colour chart tells the quantity of lime needed to correct any acid condition, which may be found.

(c) An acid condition of a soil may also be indicated by the kind of weeds found. Knot-weed, horsetail, sheep sorrel, wild strawberries, paint brush and moss thrive in an acid soil.

Explanation: Lack of lime may be responsible for soil acidity. A second cause is the decay of vegetable matter in a soil in which drainage is poor and air is not readily available. Suggest a remedy for this condition. A third cause is continuous cropping without applying lime occasionally, for the soil solution which is absorbed by the root-hairs contains lime and other bases such as magnesia. An experiment in crop rotation at Cornell Agricultural College, extending over a period of ten years, showed the removal of 3,702 pounds of magnesia per acre. This was removed by the crops and by drainage water. With such quantities of alkaline materials or bases removed from cultivated fields what condition will the soil eventually reach? How can this be prevented?

Assignment: Test the soil of your garden or of a neighbouring field for acid properties, using strips of red and blue litmus paper. When the soil is wet, insert a knife and make two slits in the soil. Into one slit insert blue litmus paper, into the other, red. Press the soil against the litmus papers by again pushing the knife blade into the soil a half inch from the paper and parallel to it. This will force the soil against the paper. After ten minutes remove the papers. Is the soil acid, basic or alkaline? How do you know? If acid, what may have caused it and how can it be corrected to grow better crops?

SOIL BACTERIA

Numerous minute plants called soil bacteria are present in good soil. They are very active in reducing organic matter and may be considered as essential to the growth of crops.

Problem 15: What is the nature and the role of soil bacteria?

Method: (a) Examine the roots of a clover plant or other legume and see that these plants have nodules or tubercles on their roots. These are formed by the activity of certain living microscopic plants in the soil, called bacteria. The nodule-forming bacteria have the power to turn the free nitrogen of the air which is present in the soil into substances which are either used by the plants immediately or remain stored in the nodules. When the nodules undergo decomposition, a humus rich in nitrogen is added to the soil.

(b) To discover the nature of nodule-forming bacteria, secure nodules from the roots of some legumes grown in the community. Crush one of each on a glass slide, add a little water and place over it a thin cover glass. Then examine the preparation with the high power of a compound microscope. You should find that there is a difference in the shape of the bacteria present in the nodules of different legumes. They are called nitrogen-fixing bacteria, because when nitrogen is converted into a useful compound it is said to be "fixed."

Explanation: Soils are alive with three kinds of micro-organisms namely, nitrogen-fixing, nitrifying and denitrifying bacteria. The nature and role of the first have been studied in (a) and (b). The nitrifying bacteria have the power to combine the nitrogen in the humus with mineral matter, especially calcium, to form nitrates which are readily soluble in soil-water and thereby made available to growing plants. The denitrifying bacteria are harmful. They attack nitrates and convert them into nitrites and ammonia which are not directly available for the use of plants.

Certain conditions are needed to promote rapid development of bacteria. The beneficial kinds require a moderate amount of moisture in the soil, a warm temperature, plenty of organic matter to provide food, a favourable supply of soil-air such as is found in well-drained soil, a slightly alkaline soil and darkness. If air is lacking and the soil is acid or sour, the harmful or denitrifying bacteria flourish in the presence of organic matter and reduce nitrates to nitrites and ammonia. Hence they stunt the growth of plants.

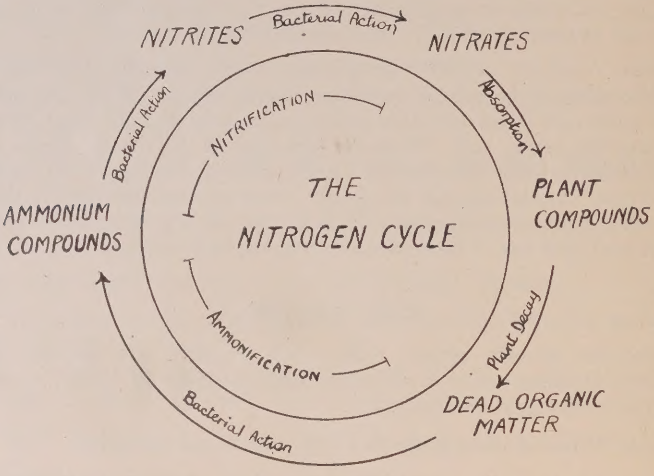

NITRITES
Bacterial Action
NITRATES
Absorption
PLANT COMPOUNDS
Plant Decay
DEAD ORGANIC MATTER
Bacterial Action
AMMONIUM COMPOUNDS
Bacterial Action
NITRIFICATION
THE NITROGEN CYCLE
AMMONIFICATION

Fig. 5. **Movement of nitrogen between soil and plants.**

Questions and Exercises:

1. Classify soil bacteria and point out the role of each.
2. How do drainage, cultivation, and the presence of humus promote the development of beneficial bacteria?
3. To grow a leguminous crop, why is it sometimes desirable to apply lime and to inoculate the soil, or the seed, with the right kind of bacteria?
4. What causes the decay of organic matter in soil? Explain why this is beneficial to the soil.
5. Read *Agriculture for High Schools* by Andrews, pp. 20–23.
6. Prepare a blank-filling test of a number of statements on soils. Fill in the blanks with the correct word or words and put brackets around each answer.

References:

Ontario Department of Agriculture
  Bulletin 364 — *Manures and Fertilizers*
  Bulletin 425 — *Legumes for Profit*

Dominion Department of Agriculture
  Publication 585 — *Manure, Fertilizers and Soil Amendments*

Section Two . . . Plant Studies
- Propagation of Plants
  - Propagation by Natural Means
  - Propagation by Man
- Seed Germination
  - Germination Tests
- Weeds
  - Recognition of Noxious Weeds
  - Regulations, The Weed Control Act, R.S.O. 1937
  - Control of Weeds

SECTION TWO
PLANT STUDIES

Approach: To appease his hunger, primitive man gathered food from herbs, trees and vines growing wild around him, and perhaps made use of other plants to supply some of his needs for clothing or shelter. As his mode of life changed he gradually developed skill in selecting, cultivating and propagating the plants which served him best. The work of improving plants and developing new varieties, by which modern man has produced the seedless orange, Marquis and Apex wheats, or the Irish Cobbler and Green Mountain potatoes, is still going on.

I

PROPAGATION OF PLANTS

Plant propagation means the production of new plants from old ones. In some cases it includes the development of new varieties of plants.

PROPAGATION BY NATURAL MEANS

Problem 1: How are plants propagated by natural means?

Methods: (a) By *seeds:* Discuss how seeds are used to obtain new plants. How do the plants develop new seeds? The growing plant produces flowers, in which the seeds develop as a result of the transfer of pollen from the stamens to the pistil. Each seed contains an embryo plant which under suitable conditions will develop into a new plant.

(b) By *sprouts* or *suckers:* Sprouts frequently shoot up from the roots of raspberry, blackberry and gooseberry plants. These may be separated from the parent and transplanted to produce new bushes. The tubers or underground stems of the Irish potato develop shoots. How can new potato plants be propagated from the tubers?

(c) By *bulbs:* Make a list of plants usually grown from bulbs. Why are bulbs able to produce rapid growth under favourable conditions?

(d) By *runners:* Discuss the development of a new strawberry patch by runners which grow along the surface of the ground and produce roots and new plants at the nodes.

PROPAGATION BY MAN

Problem 2: How are plants propagated and improved by artificial means? There are one or two unusual ways in which plants sometimes propagate themselves under natural conditions. Man makes use of these, and has also discovered other methods which can be used both to propagate and improve plants.

Methods: (a) By *cuttings:* Discuss how geranium and coleus plants are propagated. Soft-wood cuttings or slips, from well-developed shoots of the present season, are cut off immediately below the third, fourth or fifth node with a sharp knife, and are trimmed to leave only the terminal bud and a leaf or two. The prepared cuttings are then planted in moist sand to strike root at the lowest node.

(b) By *hard-wood cuttings:* Cuttings of such plants as the rosebush, barberry, poplar, privet and grape-vine may be taken in the spring from wood of the previous year's growth. Usually the cuttings are made 6–10 inches long. Each is cut off immediately below a node or bud, and planted in favourable soil. Like the soft-wood cutting, the hard-wood cutting takes root at the nodes in the ground, and the buds above ground produce leaves. Nursery-men frequently take their cuttings late in the fall, store them in moist sand or moss for the winter, and plant them in the spring.

(c) By *layering:* In the spring, branches of grape-vines and of blackberry, raspberry or currant bushes may be bent down till they are in contact with the ground and may then be covered with soil, leaving the tips of the branches uncovered. The covered portions will throw out roots. When established, the branch between the main stem and the covered part should be cut off. The result is an independent plant, which may be transplanted.

(d) By *shield-budding:* This method is commonly used to propagate and improve cherry, plum and peach trees. In late summer or early autumn, buds (scions) may be cut from the current year's growth of the desired variety and inserted into the stems of young seedlings (stocks) of the same kind of fruit.

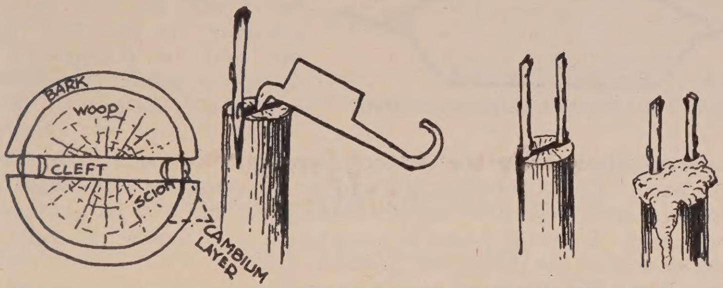
Shield-budding is done by slicing off a bud and leaf with a portion of the bark around them but with very little wood underneath. Then the leaf is cut away so as to leave only enough of its stem to serve as a handle. Near the base of the seedling to be budded a vertical slit is made downwards through the bark and also a horizontal cut across the top of the vertical slit. Then the bark is loosened from the wood around the T-shaped cut and the prepared bud is gently pushed under the bark; above the bud the projecting bark is cut off even with the horizontal cut in the seedling so that the scion-bark rests snugly against the wood of the seedling. Now the two flaps of seedling bark are pressed down and tied in position with raffia or other soft wrapping material. By these operations, carefully done, the cambium layers of the scion and stock are brought in contact with one another so union can take place. (The cambium layer is the actively growing layer of cells between the wood and the inner bark.) The following spring, after the bud begins to grow the wrapping is removed and the stock cut off 2–3 inches above the bud. From this bud will develop leaves and branches to produce a tree which will bear fruit according to the variety of the bud used.

Nursery-men use seedlings as stocks and bud them on the north side about two inches from the ground. Then when the tree is planted in a permanent position the crook produced by the budding can be set below the ground level.

(e) By *cleft-grafting:* This method of propagating a new tree or new limbs on an old tree is based on the same principle as budding, namely, bringing the cambium layer of the scion in contact with the cambium layer of the stock. The method is usually applied to apple and pear trees. By this means, new limbs yielding a better variety of fruit can be developed on a mature tree.

In the spring scions about five inches long are cut from the previous year's growth of a tree of the desired variety. Cut off the terminal bud, and below the third or fourth bud cut and trim the lower inch of the scion to form a wedge. From the mature tree to be improved saw off well-placed branches one or more inches in diameter and split each cut stock across the centre to make a cleft about two inches deep. Pry open the cleft and insert a scion on each side so that cells of the cambium layer of the scion are in contact with the cambium layer of the stock. Thoroughly cover the wound with grafting wax. This will help hold the scion in position and will exclude rain, and prevent drying out. If both scions grow, cut off the weaker one. During the next few years as the grafts grow and need more room, old branches should be cut out. This method is known as top-grafting.

In grafting neither the stock nor the scion changes its nature by the union. The fruit produced by the development of the scion will be of exactly the same kind as is produced by the tree from which the scions were taken.



(*From Canadian Agriculture for High Schools.*
The Macmillan Co. of Canada Ltd.)

Fig. 6. The Cleft Graft.

Questions:

1. What are the chief uses of cleft-grafting?
2. What time of year does the fruit grower do cleft-grafting? Budding? Layering?
3. In top-working or top-grafting an apple tree how could you cause it to bear several kinds of apples?
4. Give all the reasons you can for grafting.
5. Enumerate the various ways of propagating plants.

II

SEED GERMINATION

Good seed is necessary to produce vigorous, healthy plants. Examining the seed in the palm of the hand shows the size, shape, colour, smell and impurities but does not indicate the germinating power. The seed may be immature or old or injured by over-heating in storage. Consequently, a test is necessary to determine the germinating power. Only clean, well-developed seed with a high percentage of vigorous germination is worth planting.

Problem 3: Get acquainted with the characteristics of common farm seeds so that you may be able to recognize them.

Method: With the aid of a hand lens carefully examine wheat, oats, barley, rye, flax and buckwheat, noting their likeness and difference with respect to colour, shape, back and front sides. Try to remove the hull of buckwheat, oats and barley. Locate the germ or embryo, starting with wheat seed.

The standard weight per bushel of each is: wheat 60 lb., oats 34 lb., barley 48 lb., rye 56 lb., flax 60 lb., buckwheat 48 lb. Account for the difference in weight.

GERMINATION TESTS

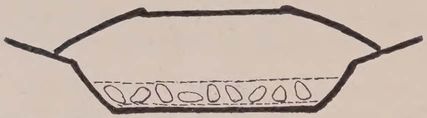
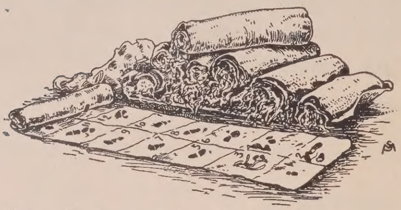


Fig. 7. Plate Method, germination test.

Problem 4: How can a germination test of seed be made to find its suitability for planting? (Count seed grain as germinated when the sprout [radicle] has developed a quarter of an inch.)

(a) Pie-Plate Method: Cover the bottom of a pie plate or a soup plate with wet blotting paper. Count out 50 or 100 seeds to be tested and place them on the wet paper. Cover them with another damp paper and over all place another plate inverted. Keep the plates in a warm place. Examine the seeds every second day and do not permit the papers to dry out. After eight or ten days, when no further signs of germination appear, calculate the percentage germination. You may also find the percentage showing quick germinating power, the percentage showing slow germination and also the percentage of seeds showing no life at all.

Under favourable conditions good seed wheat, oats and corn germinate over 90% in three to six days, while barley and turnips require six or more days. Many common flower seeds such as asters, calendula, Canterbury bells, cockscomb and forget-me-not require from ten to twenty days.



(From Canadian Agriculture for High Schools.
The Macmillan Co. of Canada Ltd.)

Fig. 8. Ragdoll Method, germination test.

(b) Rag-Doll Method: If several different kinds of the larger seeds such as corn and beans are to be tested at the same time, prepare a strip of white muslin or flannel, about eight inches wide and two or three feet long. Down the centre mark in pencil two rows of 3-inch squares and number them. Dampen the cloth and place ten or fifteen seeds on each square. After making a systematic record of the kind of seed on each square, carefully roll up the cloth and seeds on a two-inch cylinder and tie loosely at each end. Soak it in warm water for several hours, and then set the "rag-doll" upright in a warm place in an inch or two of water in a pan or beaker so that capillary action may keep the cloth moist throughout. After five or seven days unroll the rag-doll, make the counts, and calculate the percentage germinations.

Questions:

1. What are the requirements for germinating seed?
2. Suggest other methods of making germination tests.
3. Give four reasons why only clean seed showing a high percentage of strong germinating power should be planted.
4. What takes place when seeds germinate?
5. When seeds are sown in a field or garden what factors may retard germination?

III

WEEDS

Approach: The menace of weeds is one of the biggest problems that confronts farmers. To conquer them one must recognize them, know their growing habit and what to do to kill them.

RECOGNITION OF NOXIOUS WEEDS

Problem 5: To learn to recognize some noxious weeds.

Method: Secure a copy of The Weed Control Act of Ontario from the Department of Agriculture, Parliament Buildings, Toronto. Examine the list of noxious weeds of Ontario and check all those you can identify in the field.

The pupils should make a collection of *ten* or more noxious weeds found in your locality. Press and mount them according to the following directions:

Collecting: Select specimens of average size. Cut long plants into sections and mount these side by side. Some weeds have thick tap-roots or underground rootstocks. Whittle these parts to half their thickness. If you can, collect seeds from the mature plant, and mount these with clear glue beside the specimen.

Drying and Pressing: As soon as possible, put the specimen into a press of absorbent driers made from sheets of newspapers or coarse building paper. Place the plant neatly flattened out on the paper, and cover it with two or more sheets. On top of this, lay another specimen and then two more driers. Continue until all the specimens are covered. Then on top of the whole place a board and on this lay a heavy weight or a pile of books. Change the driers daily for the first few days and then every second day until the plants are dry and well pressed. The faster the drying the more natural the colour of the specimens will be. If the plants begin to mould, the drying is too slow and the specimens need airing. Change the driers more frequently.

Mounting: Place the plant in position on the mounting sheet. (No. 2 drawing book pages are suitable.) Fix it in place by strips of adhesive paper which you can purchase in small rolls from your dealer in school supplies; or you may cut narrow strips of strong paper and glue or paste a sufficient number of these horizontally across the stems, branches and leaves of the specimen to hold it securely.

Labelling: In the lower right-hand corner of the mounting sheet clearly record the Name of Plant, Duration, Habitat, Date of Collection and Name of Collector.

Problem 6: Why are these weeds likely to multiply rapidly?

Method: 1. Estimate the number of seeds that each of three of the weed specimens in your collection can produce in one season. How are their seeds adapted for dispersal?

2. Using a spade dig up several noxious weeds found in the garden, field, fence-row or roadside. Observe the underground parts to see how they produce stems that will flower and produce seeds.

3. Cut rootstocks or underground stems of Canada Thistle or Bindweed into pieces two or three inches in length. Plant them in boxes of moist sand or garden soil. Keep them moist for several weeks and observe what happens. How do they produce new plants? Cut off the part that appears above the ground and leave the rootstocks for further development. What happens? What kind of cultivation helps to spread weeds that bear rootstocks?

Explanation: A weed is "any injurious, troublesome, or unsightly plant that is at the same time useless, or comparatively so." The worst are usually the most prolific. They produce a large number of seeds and, if not cut down some time before the seeds mature, they contaminate the relatively clean fields in two or three years. A common saying is: "One year of seed gives seven years of weeds." It is estimated that a single plant of Canada Thistle or of Peppergrass produces 2,000 to 3,000 seeds; Wild Mustard, Stinkweed, Bladder Campion, or Pigweed about 20,000 each; Shepherd's Purse and Common Ragweed about 50,000; Canada Fleabane 120,000 and Tumbling Mustard 1,500,000. Such productiveness soon infests the soil with seeds if the weeds are not recognized and controlled in time. In addition, most perennial weeds have also rootstocks by which they propagate themselves.

How are weeds injurious? Since weeds grow faster, they rob cultivated plants of soil, water and sunlight. They harbour some insects and plant diseases. They increase the expense, work and trouble of the farmer. Uncut weeds always make a farm, lawn or school grounds look untidy. Burs, leaves and parts of stems, which cling to the wool of sheep, reduce the value of wool by as much as one-third. Weed seeds in grain lower its value and increase the work of cleaning the grain, if it is to be used for seed. Some weeds, such as Water Hemlock or Spotted Cowbane, when eaten may poison cattle. Other weeds, such as Wild Garlic and Ragweed, when eaten by dairy cows may cause an undesirable flavour in milk.

Questions:

1. Distinguish between annual, biennial and perennial weeds.
2. Why are perennials usually hardest to eradicate?
3. What is meant by noxious weeds?
4. Explain why weeds are a menace.
5. Describe, with examples, methods of weed-seed dispersal.

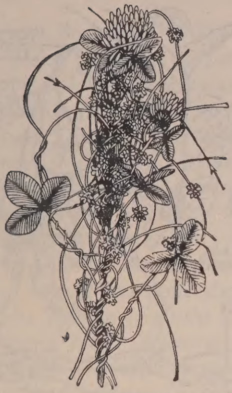


Fig. 9. Dodder.

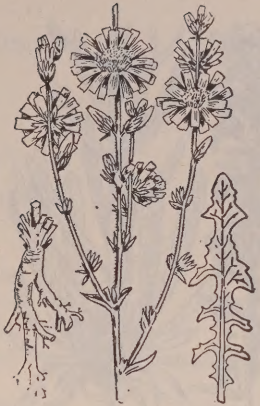


Fig. 10. Chicory.

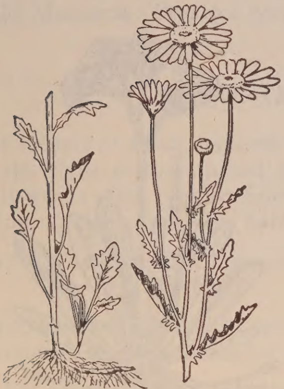


Fig. 11. Ox-eye daisy.

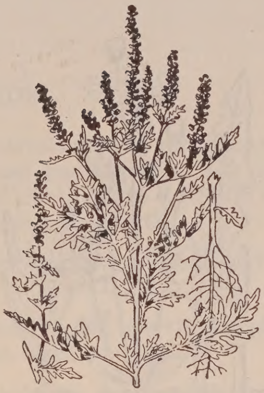


Fig. 12. Ragweed.

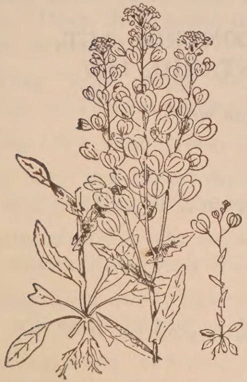


Fig. 13. Stinkweed.

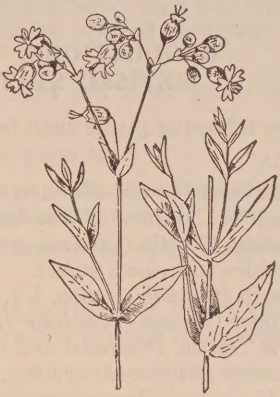


Fig. 14. Bladder Campion.

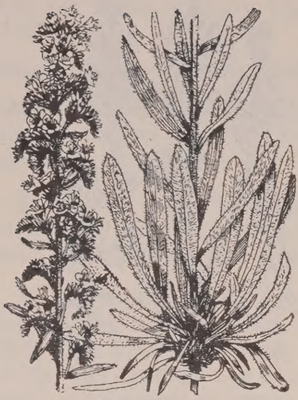


Fig. 15. Blueweed.

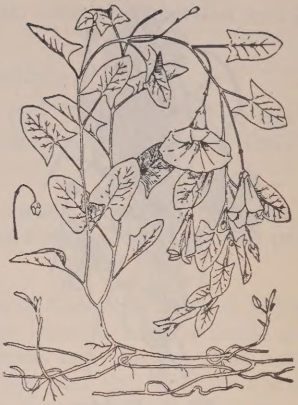


Fig. 16. Field Bindweed.

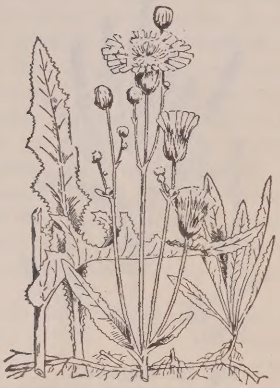


Fig. 17. Perennial Sow Thistle.

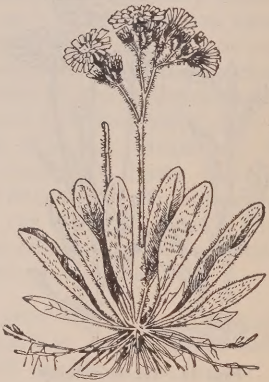


Fig. 18. Paint Brush or Orange Hawk-weed

REGULATIONS, THE WEED CONTROL ACT, REVISED STATUTES OF ONTARIO, 1937

The following plants shall be deemed noxious weeds:

Class "A"

Bindweed (*Convolvulus arvensis*, L.).
Bladder Campion (*Silene latifolia*, Mill, Britten & Rendle).
Canada Thistle (*Cirsium arvense*, L., Scop.).
Dodder (*Cuscuta species*).
Hemp (*Cannabis sativa*, L.).
Pepper Grasses (*Lepidium species*).
Sow Thistle, Perennial and Annuals (*Sonchus species*).
Spurges (*Euphorbia species*).
Wild Carrot (*Daucus carota*, L.).

Class "B"

Arkansas Bedstraw (*Galium arkansanum*, Gray).
Blue Weed (*Echium vulgare*, L.).
Chicory (*Cichorium intybus*, L.).
Cinquefoils (*Potentilla species*).
Common Burdock (*Arctium minus*, Bernh.).
Common Milkweed (*Asclepias syriaca*, L.)
Common Ragweed (*Ambrosia artemisiifolia*, L.).
Docks (*Rumex species*).
Hawkweeds (*Hieracium species*).
Ox-eye Daisy (*Chrysanthemum leucanthemum*, L.).
Poison Ivy (*Rhus toxicodendron*, L.).
Russian Thistle (*Salsola kali*, var. *tenuifolia*, G. F. W. Mey).
St. John's-Wort (*Hypericum perforatum*, L.).
Stinkweed (*Thlaspi arvense*, L.).
Tumbling Mustard (*Sisymbrium altissimum*, L.).
White Cockle (*Lychnis species*).
Wild Lettuces (*Lactuca species*).
Wild Mustards (*Brassica species*).

CONTROL OF WEEDS

The control of weeds requires a persistent determination to get rid of them. Unless the fight is maintained they will increase and cause serious losses. Different weeds often require different methods of treatment to eradicate them, depending on their duration, habits of propagation and growth.

Problem 7: What are the common methods used to control weeds and why are they effective?

Method: 1. Review The Weed Control Act of Ontario to find how this legislation aims to control noxious weeds by the co-operation of all concerned.

2. Since annual and biennial classes of weeds are propagated by their seed, discuss why each of the following practices helps to control them:

(a) Cutting down weeds with the scythe or mower before they mature their seeds. Does this means of control need to be applied to untidy rural school grounds?

(b) Growing "hoed crops" such as potatoes, corn and roots which require regular cultivation during the summer.

(c) Sowing only clean grain, clover, alfalfa or grass seed.

(d) Using only well-rotted manure on gardens or fields, especially where the feed and bedding for the livestock was produced on a weedy farm.

(e) Shallow after-harvest cultivation to encourage weed seeds to sprout so that winter frosts may kill them.

(f) Seeding down weedy fields to clovers, alfalfa or grass, for hay or pasture. How will early cutting of hay or the pasturing of animals check weeds?

(g) Pasturing sheep on weedy fields. Even on good pasture, sheep like to nip off and eat the fresh growing parts of most common weeds.

(h) Summer fallowing, which means that no crop is grown but that the land is cultivated sufficiently during the spring or the fall or during the whole season, to prevent weeds from growing.

(i) Using higher rates of seeding so that the weeds may have greater competition in their struggle for existence and may be subdued.

(j) Applying a suitable fertilizer to stimulate the health and growth of the crop to subdue the weeds.

3. Since many perennial weeds propagate themselves by their underground running rootstocks as well as by seeds, discuss why the following practices help to control this class of weeds.

(a) Summer fallowing, especially during the driest and hottest part of the season.

(b) Shallow cultivation early after harvest, with a cultivator that will not cut up the rootstocks.

(c) Growing "hoed crops" in the rotation system.

(d) Using chemical weed killers such as sodium chlorate, iron sulphate or caustic soda. These are dissolved in water and applied as a spray. The directions of the manufacturer should be carefully followed.

(e) Using a smother crop such as buckwheat and rape. These quick-growing crops deprive weeds of light and air, which weakens their growth.

Questions and Exercises

1. How can you control the dandelion and the plantain on your lawn?
2. Explain how to eradicate Poison Ivy.
3. Why should farmers co-operate in the control of weeds?
4. Why are perennial weeds harder to eradicate than annuals?
5. Give reasons for keeping all weeds cut down along fences and roads and on waste land.

References:

Ontario Department of Agriculture, Toronto
Noxious Weeds of Ontario

Dominion Department of Agriculture, Ottawa
Bulletin 30—*Weed Control in Eastern Canada*
Seeds Act, with Amendments and Regulations

Section Three . . . Live stock

- Cattle
  - General Characteristics of Dairy Breeds
  - The Common Dairy Breeds
  - General Characteristics of Beef Breeds
  - The Common Beef Breeds
  - Dual-purpose Breeds
  - Pedigreed Stock
- Horses
  - Common Draft or Heavy Breeds
- Hogs
  - Common Bacon Breeds
- Sheep
  - Common Breeds
- A Test on Live stock

SECTION THREE
LIVE STOCK

Approach: Live stock raised on Canadian farms plays a very important role in human welfare. It provides (1) food, (2) raw materials for clothing, (3) energy for doing work, (4) manure for soil fertility, (5) employment in industry and commerce, (6) interest, enjoyment and a source of income for the farmer. In this unit of study we shall endeavour to learn the characteristics of the common breeds of farm animals and how they contribute to our welfare.

I

CATTLE

Breeds of cattle are divided into three groups: dairy, beef and dual-purpose, according to their chief characteristics or uses.

What dairy breeds are kept in your district?

Problem 1: What are the distinguishing characteristics, origins and merits of our common breeds of dairy cattle?

Method: The best way to learn how to recognize breeds of cattle is to observe them on the farms, or have one of each breed brought to school. The next best way is to study coloured pictures such as have been supplied free to schools by the Ontario Department of Education. Tabulate facts about each breed as you discover them.

GENERAL CHARACTERISTICS OF DAIRY BREEDS

Examine the four dairy breeds to find that they have the common characteristic of being *triple-wedge* shaped and irregular. To do this, view the cow from the side and imagine a line along her back and another along her underside. These form the sides of a triangle. Where is the apex? The base? Now stand in front of the cow and look over her back to find another triangle with the apex at the withers or shoulder tops and the base extending across the hook bones. The third triangle represents the vertical section of the body at the withers, seen from in front of the cow. The apex is again at the withers. Because these wedges are part of the shape of all dairy cattle, they are said to be triple-wedge shaped.

A good dairy cow is straight along the back from head to tail. The body is deep and fairly low set, with a long wide rump. The udder is large with good width and length, and well balanced; the milk veins are long with many milk wells. She has a refined head and neck and light shoulders, which give her a graceful appearance. Usually she is quiet and easily managed. She has a dairy temperament; that is, she has the ability to convert her feed into much milk. A good dairy cow, well cared for, produces more human food from what she eats, than any other farm animal.

2. Which breeds are the best for a cheese-making locality?

Problem 2: What are the distinguishing characteristics, origins and merits of our leading breeds of beef cattle?

Method: Have pupils name as many breeds as they can. If the animals themselves cannot be used for study, show good pictures of Shorthorn, Hereford and Aberdeen cattle. Point out and discuss the characteristics, origin and special merits of each. Compare the breeds. Make a concise black-board summary as the study proceeds.

GENERAL CHARACTERISTICS OF BEEF BREEDS

Observe the beef breeds from the side, front, rear and over the back, as you did the dairy breeds, and you will find them to be rectangular-shaped rather than triangular. The line along the back is straight and parallel with the underline. The body is low-set, smooth, broad, deep and long, with well-fleshed shoulders and hind quarters. The head and neck are short and thick. They are said to have a beef temperament because they have the ability to convert their food into more good beef than dairy breeds.

THE COMMON BEEF BREEDS

1. SHORTHORN: Large, blocky, smooth animals; red, white or roan; head short and broad, horns short and rather flattish bending inwards and forwards; muzzle light-coloured.

Originated in the counties of Durham and Northumberland, England, about 1780.

They are considered to be the largest beef breed. Cows weigh from 1300–1500 pounds, bulls, 2200–2500 pounds. Fairly quiet disposition.

2. HEREFORD: About as large as a Shorthorn, compact, with short legs; coloured red, with white face and white extending over neck, withers and underline; feet and switch also white; head short with broad horns which are heavier than in Shorthorns and bend downwards; muzzle light in colour; less quiet than Shorthorns.

They originated in the County of Hereford, England.

Herefords grow fast at an early age and are good producers of baby beef; hardy, strong constitutions; excellent grazers and rustlers on the range.

3. ABERDEEN ANGUS: Smaller, more compact and rounder body than Shorthorns and Herefords; all black; hornless with head tapering at the poll; black muzzle.

They were first developed in Aberdeenshire, Scotland.

These cattle have a fine quality of flesh with less waste than perhaps any other beef type. They are excellent for stall feeding, and fair on the range; at a year old they make choice baby beef.

Questions and Exercises:

1. Direct pupils to collect and mount in their agricultural notebook, good clippings of the beef breeds.
2. Why do beef breeds develop more meat than dairy breeds?

DUAL PURPOSE BREEDS

The dual-purpose Shorthorn has been developed from some strains of the beef Shorthorns which had a tendency to produce more milk than others. Gradually they have been bred up to the capacity of producing large quantities of milk from the feed consumed, rather than building up a fleshy body. This type is related to the old Durham cow, brought to Canada from England by pioneers, and has a conformation which stands between the beef and dairy types. The cow serves well for a few years as a milk producer and after that she is more valuable for the purpose of beef than any other of the dairy breeds. She has a good constitution and a mild disposition. Breeders, however, find difficulty in maintaining dual-purpose cattle true to type.

The Red Polled, the Brown Swiss and the Devon are other dual-purpose breeds, but these have never become numerous in Canada.

PEDIGREED STOCK

You may know of someone in your neighbourhood who has pedigreed cattle. That means they are pure-bred, of high quality, and registered in the Herdbook for that breed in the National Live Stock Records Branch, Ottawa. For example, Augusta Fancy =166122= a distinguished pure-bred Shorthorn cow at the Ontario Agricultural College is a pedigreed animal since she is registered in the Shorthorn Herdbook at Ottawa, where her line of ancestors can be traced. (The two dashes before and after her number indicate that it is Canadian). Breeders and buyers of high-class stock study pedigrees because "like begets like" and they know that pedigreed animals have had superior qualities bred into them for many generations. Cattle not registered, or not *pure-bred* are either *grades* or *scrubs*.

All the pedigreed breeds are registered at Ottawa, excepting Holsteins which are registered at Brantford with the secretary of the Holstein-Friesian Breeders' Association.

Questions and Exercises:

1. Find out who have pedigreed cattle in the locality and what breeds are represented.
2. Describe the udder and milk veins of a good dairy cow.
3. Describe the general characteristics of the beef animal.
4. Explain why scrub cattle are less profitable to the farmer than well-bred cattle.

References:

Types and Breeds of Farm Animals by Plumb; Ginn & Co., Toronto.

II

HORSES

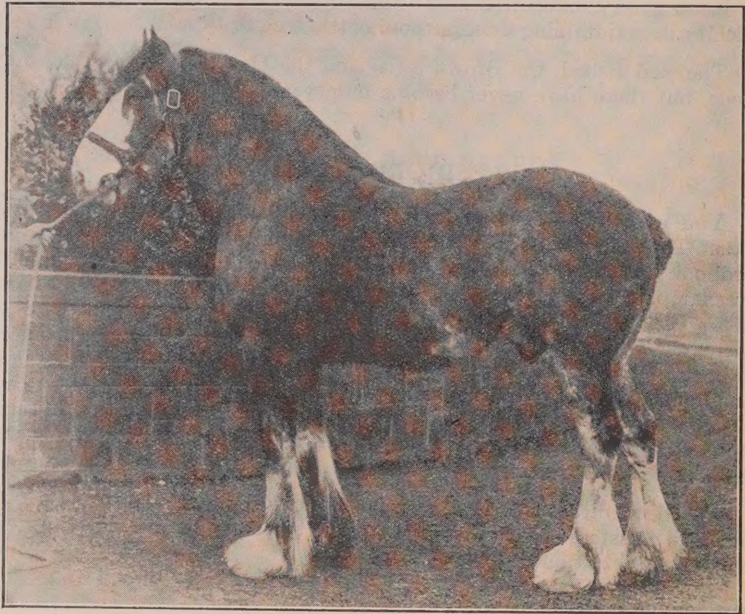
The two main types of horses are heavy and light. Many horses found on Ontario farms are between these two classes. This study is concerned with the heavy or draft breeds.

Name any breeds of heavy horses you can identify.

Problem 3: What are the characteristics and origins of common breeds of draft horses?

Method: Study good pictures of typical Clydesdale, Percheron and Belgian horses to find their markings and general conformation. Also, where possible, observe good horses of these breeds and compare them.

Tabulate a brief description of each breed giving colour, head, neck, legs, feet, body conformation and origin.



(Ontario Dept. of Agriculture)

Fig. 22. Clydesdale.

COMMON DRAFT OR HEAVY BREEDS

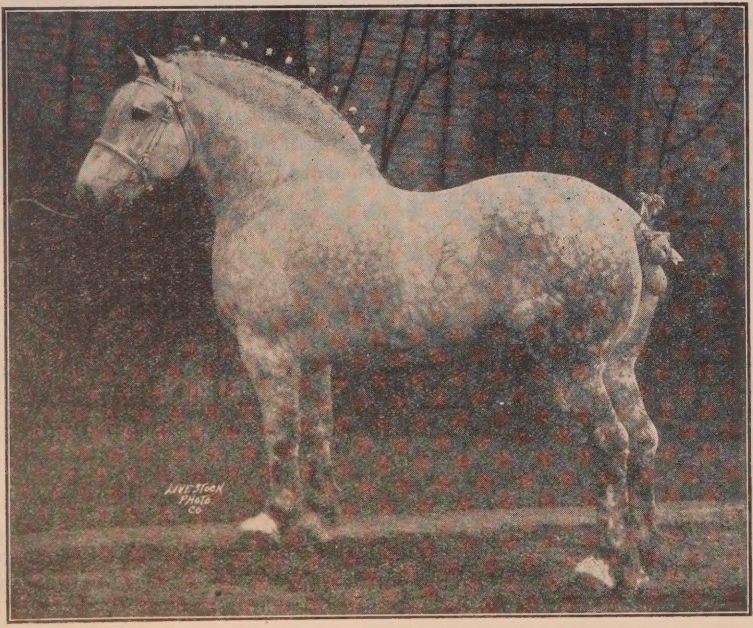
1. Clydesdale: The colour is generally bay or brown, with a white strip on the face and usually some white on the legs up to the hocks and knees. The lower leg bones (cannons) are flat and strong and support a characteristic growth of long fine hair. This hair is a disadvantage during muddy and snowy weather. In conformation the breed is comparatively rangy with a fairly straight, broad back and a deep, full middle. This gives it a good walking and

trotting action. The breed was first imported from Scotland about 1850 and has become a very popular draft breed in Canada. The usual range in weight is from 1600 to 2100 pounds.

2. Percheron: Its colour is commonly gray or black and sometimes there is a white star on the forehead. In comparison with the Clydesdale the leg bones are not as strong and flat, the cannons lack the excessive hair growth, and the feet are deeper but smaller. In conformation the body of the Percheron is compact and blocky in form, its chest is full and its back broad. It has a smart, walking and trotting gait. The breed was imported from France about 1850, and now is second to the Clydesdale in popularity in Canada and ahead of it in the United States. The breed ranges in weight from 1600 to 2000 pounds.

3. Belgian: This breed is commonly roan, bay or chestnut. Its head is smaller and more refined than either that of the Clydesdale or the Percheron. As in the Percheron, the bones of the legs are not as flat as those of the Clydesdale, and the cannon supports no long hair. The legs are shorter and the feet medium in size. In conformation this horse has a shorter and more massive body and neck, and a fuller middle than either of the two other draft breeds. Owing to these features, it has a somewhat rolling gait, though the action is quite good. The breed was imported from Belgium later than the Clydesdale and Percheron and is gaining in popularity, especially in Western Canada. Its weight has quite a wide range.

In all the draft breeds the stallions weigh more than the mares or the geldings.



(Ontario Dept. of Agriculture)

Fig. 23. Percheron.

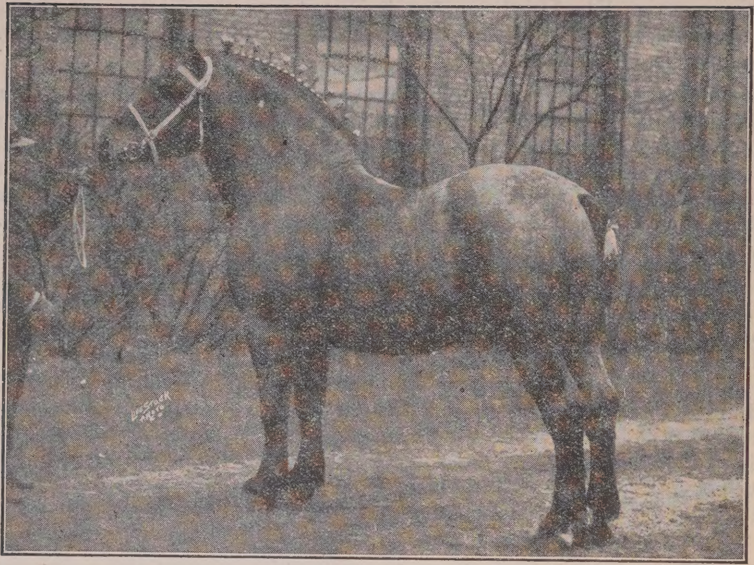


Fig. 24. Belgian. (*Ontario Dept. of Agriculture*)

Questions and Exercises:

1. Whenever you have the opportunity go to a fair and observe the draft horses in the show ring.
2. What are five desirable features of a draft horse?
3. Which breeds are raised in your community?
4. What do you think of the influence of the motor truck and the tractor on the draft horse industry?

III

HOGS

The two distinct types of hogs are the *bacon type* and the *lard type*. The former is by far the most popular in Canada and bred for the production of Wiltshire Sides*. The lard hog is common in the United States, especially where corn is the chief hog feed.

Name common breeds of hogs you can identify.

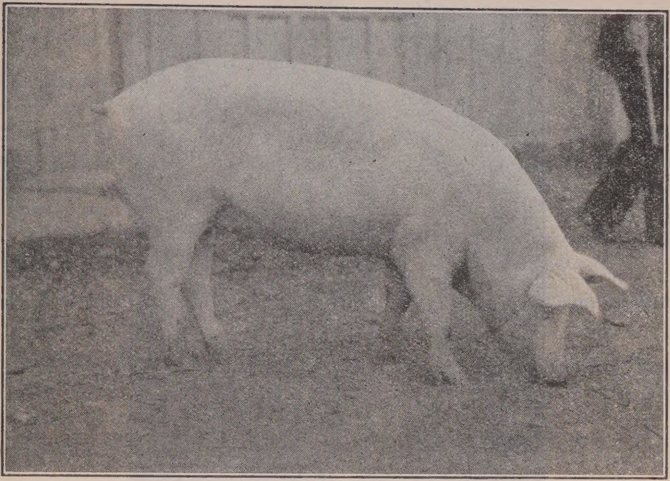
Problem 4: What are the characteristics of our bacon breeds?

Method: 1. With the aid of pictures of good types, discover which bacon breeds you have seen in the community.

2. Investigate the distinguishing features of the Yorkshire, Tamworth and Berkshire breeds of hogs. Tabulate a brief description of each breed with reference to colour, head, jowl, back, length and depth of sides, feet.

---

*A Wiltshire side consists of one-half of a slaughtered hog, including the ham, shoulder and side. This is the usual form for export to Britain.



(*Ontario Dept. of Agriculture*)

Fig. 25. Bacon type.

COMMON BACON BREEDS

1. YORKSHIRE: Colour white; head wide between the eyes, face slightly dished, snout straight, ears of medium size and carried erect; neck of medium length with a neat jowl; shoulders compact; sides long, fairly deep, and uniform from the shoulders to the hams; back arched and the underline straight; legs medium length and strong.

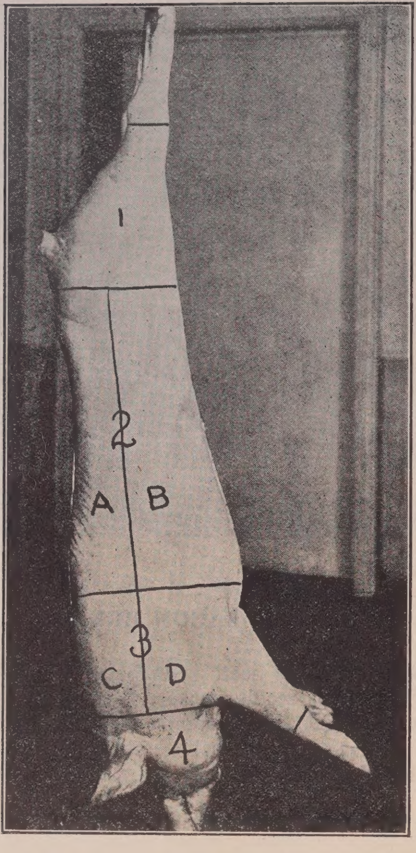
In Canada the Yorkshire is the most popular bacon breed.

2. TAMWORTH: Colour golden red which darkens with age; head narrow between the eyes, face straight and snout long and straight; ears large and carried erect; neck long and a light, trim jowl; shoulders smooth and medium in length; sides long and fairly deep with a trim underline; back arched and usually thicker than that of the Yorkshire; legs strong and apparently long.

This breed yields choice bacon, but packers find that the carcass is sometimes a little too fat along the back, and the flesh-coloured skin is not favoured like the white skin of the Yorkshire.

3. BERKSHIRE: Colour black with white markings in the face, on the feet and the tail; head short, face dished and snout short; neck short and thick; a fairly heavy jowl; body deep, with shoulders, back and hams thicker than those of the Yorkshire and Tamworth; legs strong but short in appearance.

The bacon-type Berkshire was developed from the old thick lard-type Berkshire. Objection is sometimes taken to its dark skin.



(*Ontario Dept. of Agriculture*)

Fig. 26. Standard Pork Cuts.

(1) Ham. (2) Middle (A—Back, B—Belly). (3) Shoulder (C—Shoulder Butt, D—Picnic Shoulder). (4) Head.

These three breeds of hogs originated in England and were imported into Canada. Canadian breeders have so improved them that in six months, or 190 days, under proper care and feeding, any one of the three breeds will develop to a live weight between 190–210 pounds. This is the choice age and weight for the production of select export bacon.

Questions and Exercises:

1. Make an outline drawing showing the shape of a good bacon hog. Label the parts you have learned.
2. State three distinguishing features of the Yorkshire, Tamworth and Berkshire breeds.

IV

SHEEP

Man's interest in sheep is very old. Abraham was a herdsman and measured his wealth in sheep and cattle. Since those far-off days new breeds of the mutton type have been developed in the British Isles and breeds of the wool type in France and Spain. We have imported the breeds we desired for the production of wool and mutton. Their upkeep is not costly since they are good foragers; but they are timid animals and need protection from danger, from cold and bad weather. Each breed has its own identification characteristics and is classified according to the quality of wool it produces.

Problem 5: What are the characteristics of the common breeds of sheep and how are they classified?

Method: Study good pictures of the breeds to find distinguishing characteristics. Verify what you found with the description below. Observe well-bred sheep on farms or at fairs where live stock is shown.

COMMON BREEDS

(*a*) *Long Wool Breeds—Mutton Type*

1. LEICESTER: Head, forehead and face free from wool, with a distinctly Roman form of nose. Body—rectangular, broad, somewhat shallow with long white legs. Weight—least of the long-wool breeds (200–250 pounds). Fleece—of fine quality, with wool about six inches long.

2. COTSWOLD: Head—white, or blotched with gray. Wavy lock of wool hangs down over the face. Body—heavy in fore quarters (200–275 pounds). Fleece—comparatively coarse wool hanging in large locks.

3. LINCOLN: Head—white, with tuft of wool on the forehead, nostrils dark. Body—broad and good depth (260–300 pounds). Fleece—of long coarse wool, heavy.

(*b*) *Medium Wool Breeds—Mutton Type*

1. SOUTHDOWN: Head—short and broad, covered with a cap of short wool extending to the eyes. Face bare and grayish. Body—compact and blocky (135–175 pounds). Fleece—dense and of fine wool 2½ inches long.

2. SHROPSHIRE: Head—short and broad, covered with a cap of wool down to the dark brown nose. Body—blocky, broad and deep, with dark wool on the legs (160–250 pounds). Fleece—not as dense as that of Southdown, medium fine wool.

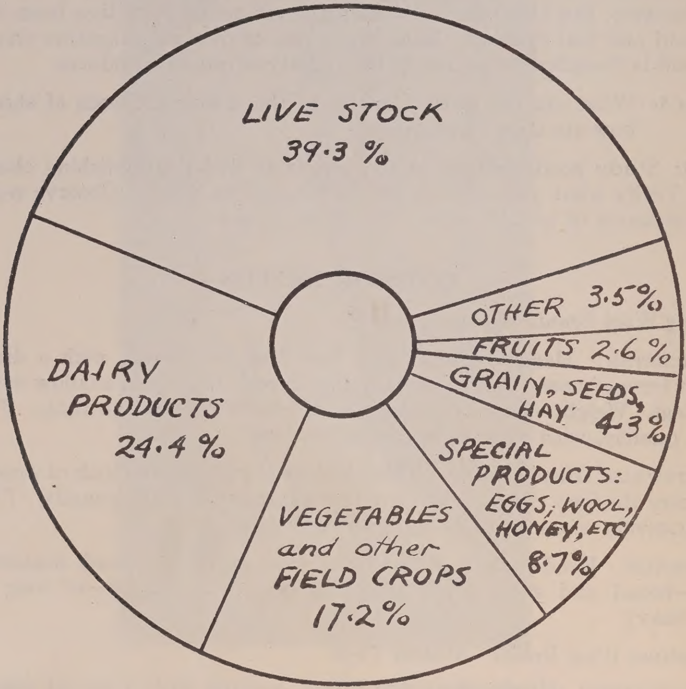
3. HAMPSHIRE: Head—large with a cap of wool extending to just below the eyes; dark Roman nose, ears long, heavy and dark. Body—not as round and low set as the Shropshire (190–260 pounds). Fleece—good quality, medium density, lower grade than that of Shropshire and Southdown.

4. OXFORD: Head—long straight profile, wool cap over the forehead, face dark, ears large. Body—rectangular, broad, deep and upstanding, dark wool on legs, (200–400 pounds). Fleece—fairly compact, wool coarser and longer than that of other medium wool breeds.

5. CHEVIOT: Head—free from wool, face clear white, nose slightly Roman resembling that of the Leicester, ears carried alertly. Body—upstanding on white legs nearly free of wool (160–225 pounds). Fleece—lacks density, neither fine nor coarse.

(*c*) *Fine Wool Breed—Wool Type*

1. MERINO: Head—short and broad. Rams have spiral-shaped horns. Wool cap on forehead. Body—lacks depth and breadth, small (100–200 pounds).



(*Ontario Dept. of Agriculture*)

Fig. 27. Percentage of Cash Income from the Sale of Farm Products 1943.

front legs of a breed of sheep indicates a strong constitution. In this respect the medium wool breeds, which are general-purpose sheep, rank high.

Fleece—heavy folds of fine-quality wool around the neck and shoulders. Large quantity of wool.

You have observed from your study of breeds of sheep that they are grouped into two types. The mutton type has been developed to be highly efficient in the production of mutton, and the wool type to be highly efficient in the production of very fine wool. In general the body conformation of the mutton type is similar to that of the beef type of cattle, being rectangular, broad and deep, while the wool type is similar to that of the dairy type of cattle, being smaller and rather narrow and angular. Good width between the front legs of a breed of sheep indicates a strong constitution. In this respect the medium wool breeds, which are general-purpose sheep, rank high.

Questions and Exercises:

1. Prepare a blank-filling test of 10 statements on sheep. In each blank space place the correct word or phrase in brackets.
2. Find out which breeds of sheep are kept in the community.
3. Examine a hair and a wool-fibre under the microscope and make drawings to indicate the difference.

Problem 6: What values have live stock in farming?

Method: Discuss reasons for keeping horses, cattle, hogs and sheep on a farm. Make a board summary of points as the discussion proceeds.

Live stock is kept on the farm either because it is directly useful to the farmer or because it constitutes a source of revenue. In the first category are those animals which supply the farmer with meats, milk, cream, butter or other foods. The work accomplished by horses is also directly useful. In the second class, revenue is obtained from the sale of wool and milk as well as from the sale of cattle, sheep and hogs for food. Surveys show that farming is most profitable and the risks most reduced when attention is given to the wise selection, proper keeping and careful marketing of live stock.

(*Courtesy, Farmer's Advocate*)

Six-Horse Hitch

Keeping live stock reduces waste on a farm. Sheep and horses will feed during the summer on semi-arid pastures which would otherwise be unproductive. Sheep are good scavengers for controlling weeds. Calves and hogs may be fed on the skimmilk, buttermilk or whey which are by-products of dairying. During the winter, live stock consumes roughage such as straw, hay and silage which are primary farm products, as well as concentrates such as bran and shorts which are by-products of the flour-milling industry. All these types of foods promote the growth of the animals and are thus converted into saleable products.

Keeping live stock spreads the farmer's work over the whole year and helps to provide steady employment both winter and summer for the hired man. Since it solves a vexed problem, this is another reason why diversified or mixed farming is popular.

The progressive farmer must maintain soil fertility. Chemical fertilizers and green manures can supply part of the needs of the soil, but the farm which is well stocked with animals has in barnyard manure the most valuable source of fertilizer. From the manure the soil receives again a proportion of the materials which were taken from it to provide the growth of the green crops.

The farmer with a well-kept farm and carefully tended stock is a successful farmer. He is successful because of those traits of character which are revealed in his attitude towards his stock. The daily care of farm animals not only requires thoughtfulness and kindness, but it must inevitably, by the constant exercise of these humane qualities, have its effect on his whole character and be manifest in his general outlook on life.

Problem 7: Show what industries depend directly upon live stock for raw materials.

Method: Discuss the industries in your locality that depend upon live stock for providing their raw materials.

(*Courtesy, Farmer's Advocate*)

An Old Method. The ox-cart

Cattle, hogs and sheep are shipped to slaughter houses and packing plants. Warehouses store the products for resale. The meats are distributed to retail shops. The hides are sold to tanneries where they are converted into leather, which in turn is sold to manufacturers of leather goods who make shoes, harness, valises, purses and other leather articles. Bones and some other parts of the carcasses unfit for human food go to factories where they are converted into fertilizers to be returned to the soil. Some of the hoofs and bones are used for making glue and also in processes for the manufacture of gelatin.

The dairy industry with its many ramifications is maintained by the dairy cow. The urban dairy pasteurizes milk and sells it to the consumer. Large quantities of milk are also processed into condensed milk, powdered milk or commercial casein. The latter substance is used in many ways—in plastics, glues and paints, to mention only a few. Many dairies also make ice cream. Cheese factories and butter factories, which buy their milk and cream directly from the farmers, are found in most localities.

A TEST ON LIVE STOCK

Directions: Fill the blanks with the proper word or words to make the statements correct.

1. The general shape of the beef animal is..
It has the ability to convert its feed chiefly into..

2. The general shape of the dairy animal is...
It has the ability to convert its feed chiefly into..

3. The common breeds of dairy cattle are: 1. ....
2. .... 3. .... 4. ....

4. The breed of cattle noted for both milk and beef production is the
.... Its colour is...

5. The breeds of cattle originating in the Channel Islands are:
1. .... 2. ....

6. The three leading breeds of draft horses are: 1. ....
2. .... 3. ....

7. The breed of horse with a white face and usually four white feet and legs is..

8. The choice bacon hog is the..
and its colour is..

9. A bacon hog, when marketed, should be.................old and weigh...............

10. The Cotswold belongs to the...............................breeds; the Lincoln to the
....breeds; the Cheviot to the...............................

11. The mutton type of sheep are the.......................breeds and the...................
breeds.

12. The two breeds of sheep with a clean white face and a Roman nose are:
1. .... 2. .... The heavier of these
breeds is the..

13. Industries that depend upon live stock for raw materials are:
1. .... 2. .... 3. .... 4...........................

14. Three advantages of raising beef cattle are: 1. ....
2. .... 3. ....

15. The two main products from milk are: 1. .... 2........................

16. Three by-products of dairying on the farm are: 1. ....
2. .... 3. ....

Section Four . . . Milk

- Composition and Food Value of Milk
  - The Vitamins in Milk
  - Percentage Composition of Milk
  - Importance of the Babcock Test
- Pasteurization of Milk
- The Care of Milk from the Cow to the Consumer

SECTION FOUR
MILK

Approach: Milk is acknowledged to be the most nearly balanced food provided by nature for man, even though deficient in iron and vitamin C. It contains the nourishing substances needed in a diet for the growth and health of children and for repairing worn-out tissues of adults. Milk, however, may be a dangerous food, if it is drawn from unhealthy cows, or if it becomes contaminated with harmful bacteria by improper handling or lack of care. It is, therefore, necessary to understand and appreciate what good milk means and what precautions are needed to keep it sanitary and wholesome.

Important things to think about:

1. How to find the composition of milk.
2. Why milk and milk products are important foods.
3. How the percentage of fat in milk is determined.
4. How milk may become contaminated on its way from the cow to the consumer.
5. Why and how milk is pasteurized.
6. Essential factors in the care of milk.

COMPOSITION AND FOOD VALUE OF MILK

Problem 1: To separate and observe the constituents of milk and to appreciate its food value.

(*a*) *To Test for Fat in Milk and to Observe the Fat Globules*

Method: Try to make the characteristic "grease spot" test for fat by putting a drop of cream on thin, unglazed white paper, and spreading it out. A translucent spot after drying indicates fat.

Put a drop of milk on a microscope slide. Dilute it by adding an equal quantity of water. Spread it into a thin layer with the end of another slide. Examine the layer using the high-power objective of a compound microscope. Are the globules numerous and uniform in size? Make a drawing of their shape and relative size as observed on the slide. If dark particles are seen in the milk, they are dirt which entered through careless milking or unclean handling.

The tiny globules observed are the milk-fat* constituent floating in the serum of milk. They range from 1/15,000 to 1/25,0000 of an inch in diameter, and one drop of milk contains about one hundred million of them. Their size and number vary with the breed, individuality and stage in lactation of the cow. Usually the milk from Jersey and Guernsey cows contains larger globules than that from Holsteins and Ayrshires.

---

*Milk-fat and butter-fat are the same thing. The latter term is used in the Ontario Milk and Cream Act.

Questions and Exercises:

1. How is milk-fat commonly removed from milk?
2. Why does cream rise to the top of milk?
3. Which is heavier, a pail of cream or a pail of milk?
4. What is the chief product made from cream?
5. Explain how to do a grease-spot test for fat.
6. What is homogenized milk?

(*b*) *To Separate Casein from Milk and Test It for Protein*

Method: Warm a test tube half full of skimmilk. Add a teaspoonful of vinegar, or a rennet tablet. Shake and gently heat the mixture until it is well curdled. Strain the curdled mixture by filtering it through cheesecloth or through a disk of filter paper folded in quarters and fitted into a funnel. Catch the liquid which runs through in a test tube or beaker. The matter left on the filter (residue) is the casein, and the liquid that ran through (filtrate) is whey. Save the whey for later analysis.

Test the casein or curd for protein by adding a little strong nitric acid to a clot of it put into a test tube. A yellow colour indicates protein.

Record how to separate casein from milk.

(*c*) *To Find Albumin in Milk and Test It for Protein*

Method: Slowly heat 300–400 ml. of skimmilk, buttermilk or whey in a beaker. Before it boils (170–180 degrees F.) observe a glazed portion on the top of the milk. This skin-like layer is chiefly albumin. It is coagulated by heat above 160 degrees F. and not by rennet or vinegar (acid).

How would you test albumin to find if it is a protein?

The quantity of albumin in milk is small, but it is an important factor in the preservation of milk. As food, it is a protein like casein, but differs from casein in composition and behaviour. When whole milk is heated, albumin, together with some fat, coagulates and comes to the top before the boiling point is reached.

Questions and Exercises:

1. What food is commonly made from milk-casein?
2. What does the cheese-maker use to separate casein from whole milk?
3. Why does cheese contain fat as well as protein?
4. Why does cheese, as a food, build muscle and nerve tissue and also supply heat and energy?

(*d*) *To Test for Sugar in Milk*

Method: Put 5–10 ml. of whey into a test tube and add half as much Benedict's Solution, or Fehling's Solution. Slowly boil the mixture, noting the gradual change in colour. With Benedict's Solution a green colour indicates milk-sugar (lactose). With Fehling's Solution* a light red indicates milk-sugar.

As a food milk-sugar and milk-fat supply energy and produce heat.

---

*Fehling's Solution is prepared and kept as follows:

1. In 50 ml. of distilled water dissolve 3.5 grams of copper sulphate and label the solution A.
2. In 50 ml. of a 10 per cent solution of sodium hydroxide in water, dissolve 17.5 grams of Rochelle salts and label the solution B. When ready to test for sugar, mix equal quantities of A and B and add the mixture to the substance to be tested. Heat, and note change in colour. Either Fehling's Solution or Benedict's Solution, which is a modification of Fehling's, may be purchased at your local drug store.

(*e*) *To Find Water and Mineral Matter in Milk*

Method: Put 200 ml. of skimmilk into a small aluminum saucepan, or evaporating dish. Evaporate to dryness by setting the evaporating dish on a wire gauze over a flame. While boiling hold a cold clean glass plate in the vapour for a minute. Observe what condenses on the glass. Taste it. What is the heat driving off?

Continue to heat the residue strongly and note the charring. The brown colour which first appears indicates the burning of sugar. After the colour has changed to gray, cease heating. What you have left is ash, or the mineral matter of milk, containing chiefly calcium and phosphorus. The chemist determines their presence by tests too advanced to be undertaken here.

The calcium and phosphorus in milk, and in cheese made from milk, are essential elements in a diet for the development of bones, teeth and nails. Dr. Frederick Tisdall, Director of Nutritional Research Laboratories of the University of Toronto, writes in *What to Eat for Health*—"Our greatest sources of calcium are milk and milk products. To get an adequate supply, adults should consume each day from one-half to one pint of pasteurized milk, while the growing child who is forming new bones should take one pint and a half of milk."

THE VITAMINS IN MILK

Very important to growth and health are the vitamins contained in wholesome milk and its products. Those most abundant are the vitamins sometimes called A and B_2, with lesser amounts of vitamins B_1 and D. They regulate body activities and increase resistance to disease.

PERCENTAGE COMPOSITION OF MILK

In the previous laboratory exercise the chief constituents of milk were found. The percentage of these in whole milk, according to Professor Henry H. Dean, is approximately:

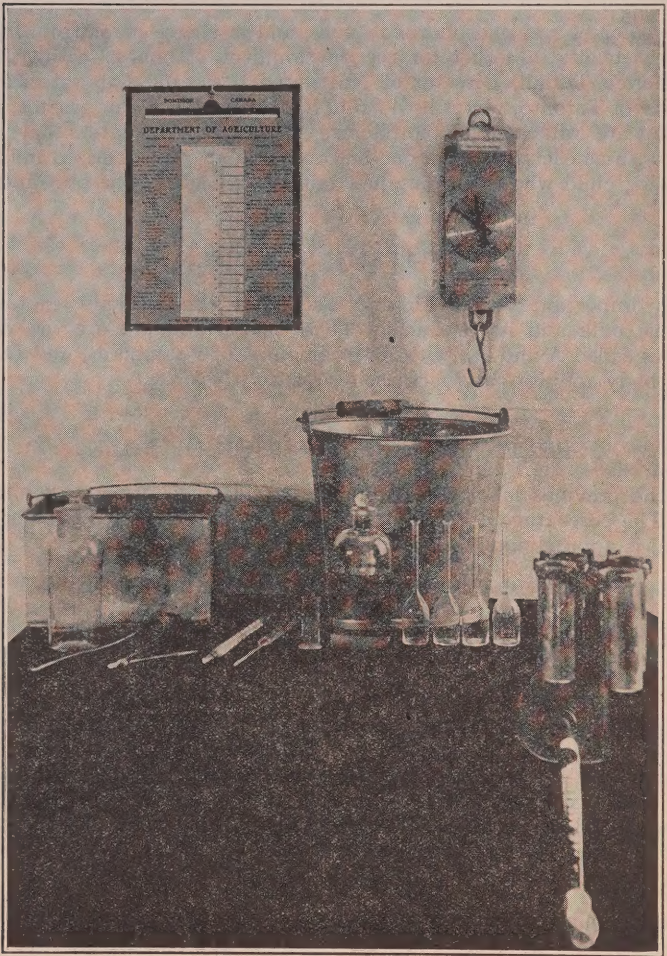
Water	87.5%
Fat	3.6
Casein	2.5
Albumen	0.7
Sugar	5.0
Ash	0.7
	100.0%

The quantity of each of these constituents varies depending on the breed and individuality of the cow, the care and feeding, the season of the year, the advancement of the lactation period and the completeness of milking. The greatest variation is in the quantity of butter-fat, which may range from as low as two per cent to as high as ten.

The foregoing constituents in the composition may be grouped under two divisions, namely—1. Water. 2. Total Solids. The total solids may be subdivided into (a) fat, (b) solids not fat. Today milk is bought and sold on the bases of weight or measure, percentage fat, flavour and cleanness.

Questions and Exercises:

1. What does milk contain that makes it a very important food? What mineral necessary for growth is lacking in milk?
2. How much milk should a growing youth consume daily?
3. What is obtained from milk to make (a) butter? (b) cheddar cheese? (c) cottage cheese?
4. How are butter-fat and casein commonly separated at home from milk?
5. What are the by-products of butter-making and cheese-making? What use is commonly made of them?
6. Read Publication 635, *Milk the Food of Foods*, pp. 3–5, Dominion Department of Agriculture, Ottawa.



(Ontario Dept. of Agriculture)

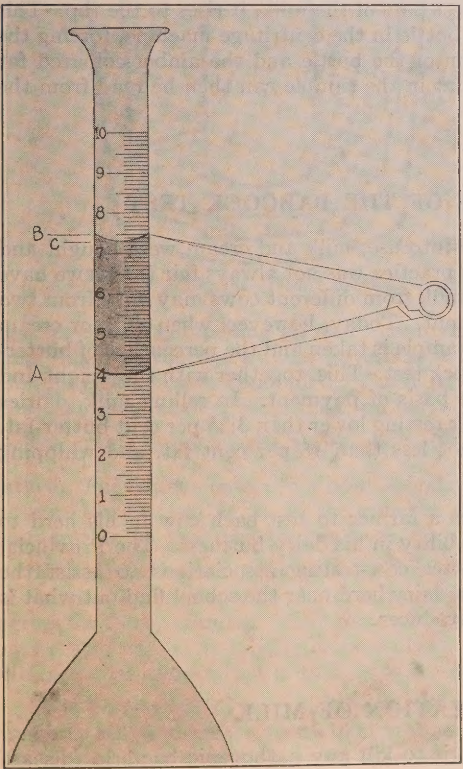
Fig. 30. Babcock Test Apparatus.

Problem 2: To determine the percentage of fat in whole milk by the Babcock test. (Where this is undertaken in Public and Separate Schools the teacher should perform the test because of the danger involved.)

Equipment: (1) Babcock centrifuge, (2) two Babcock whole-milk test bottles, (3) pipette for measuring 17.6 ml. of milk, (4) an acid-measurer for measuring 17.5 ml. of sulphuric acid.

Directions: (Be careful and accurate.)

1. Mix the sample of milk thoroughly by pouring it from vessel to vessel. Raise the temperature to 60–65 degrees F.
2. By means of the pipette, measure out 17.6 ml. of milk and carefully put it into a Babcock whole-milk test bottle held on a slant.
3. With the acid-measurer, measure out 17.5 ml. of concentrated sulphuric acid. (Specific gravity 1.82 to 1 83.)
4. Hold the test bottle containing the milk on a slant and slowly pour the acid in so that it runs down and takes its place under the milk.
5. Slowly mix the milk and acid by holding the bottle by the stem and gently rotating it until the mixture becomes a uniform chocolate colour. Note the heat generated by chemical action.



(*Ontario Dept. of Agriculture*)

Fig. 31. Measuring the fat column.

6. Place the bottle in the Babcock centrifuge. Prepare another bottle as a duplicate and place it in the centrifuge opposite the first bottle to balance the machine.
7. Whirl the bottles for *five* minutes at the speed indicated on the machine. Then slowly bring it to a stop.
8. Remove the bottles and by means of a pipette add enough hot water (160 –170 degrees F.) to fill each *just up to the base* of the neck. The water should be distilled or soft to prevent foaming.
9. Put the bottles back into the machine and whirl them again for *two minutes*.
10. Again remove the bottles from the machine and very carefully add more hot water until each bottle is filled nearly to the top of the graduation scale of the stem. Observe milk fat in the stem of the bottles.
11. Now again whirl the bottles in the centrifuge for *one more* minute.

12. Remove the bottles from the centrifuge and place them in a water-bath at a temperature of 130–140 degrees F. Immerse the bottles to the level of the top of the fat column. The function of the water-bath is to standardize the temperature at which the fat readings are made. The fat column should be a clear golden yellow and the top and bottom curves sharply defined.

13. Remove the bottles from the water-bath and with a pair of dividers measure the length of the fat column by holding one pointer of the dividers at its upper limit and the other at its lower limit. In doing so, hold the bottle at the level of the eye. Then keeping the arms of the dividers the same distance apart, place the lower pointer at zero on the scale and read the position of the other pointer above it on the scale. The reading of the length of the fat column from the scale is the percentage of fat in the milk.

The Babcock tester was invented in 1890 by the late Dr. S. M. Babcock when chief chemist of the Wisconsin Experimental Station. The test is based on the fact that 17.5 ml. concentrated sulphuric acid will dissolve all the solids in the 17.6 ml. of whole milk excepting the milk-fat (0.1 ml. of whole milk adhered to the pipette). This sets the particles of fat free that they may run together. Since the fat is the lightest part of the milk, it rises to the top. This action is hastened by whirling the bottle in the centrifuge machine, forcing the heavier brown liquid to the bottom of the bottle and the amber-coloured fat into the neck. The percentage of fat in the sample can then be read from the graduated neck.

THE IMPORTANCE OF THE BABCOCK TEST

Before the Babcock test came into use, milk and cream were bought and sold by volume or by weight. This practice was not always fair for, as we have seen, the quantity of butter-fat in milk from different cows may vary from two per cent up to as high as ten per cent. Today, however, when milk or cream arrives at the dairy or creamery, a sample is taken and the percentage of butter-fat in it is determined by the Babcock test. This, together with the weight and condition of the milk, is made the basis of payment. In selling milk, dairies are not permitted by law to sell milk testing lower than 3.25 per cent butter-fat. Likewise table cream should test not less than 18 per cent fat, and whipping cream from 28–32 per cent.

The Babcock test also enables a farmer to test each cow in his herd to find whether she is an asset or a liability in his dairy business. The Provincial Department of Agriculture promotes cow-testing associations to assist the farmers in this matter. If there is a dairy herd near the school find out what is done there to eliminate the low producer.

PASTEURIZATION OF MILK

The purpose of pasteurization is to kill any pathogenic bacteria (disease germs) that may be present in milk because of unhealthy cows or careless handling. Pasteurization also reduces the number of lactic acid bacteria which cause milk to sour. Thus it improves the keeping quality of milk as well as making it safe to use.

Records show that at various times whole families, and even whole communities, have been seriously affected by using unpasteurized milk. In one community as many as four hundred cases of typhoid fever were traced to milk that had been handled by one person who was a typhoid carrier. Pasteurization could have prevented this. For such reasons there is today a public health measure or law compelling all dairy companies of Ontario to pasteurize their milk. Their methods are under government inspection and a high standard of care and cleanliness is demanded. The dairy companies, in turn, are requiring from the dairy farmers clean milk, properly handled and cooled.

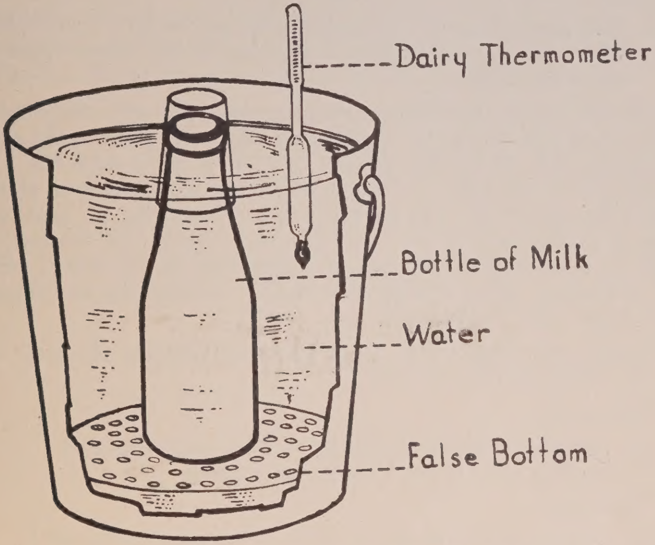


Fig. 32. Home method of pasteurizing milk.

Problem 3: To learn how to pasteurize milk in the classroom, or at home.

Method: For convenience use a double boiler. Half fill the lower section with water and begin heating it. In the upper section put the milk and in it a dairy thermometer so that the temperature may be watched.

Heat until the milk is raised to 145 degrees F. and at intervals stir it with the thermometer. Regulate the heat to maintain the temperature at 142–145 degrees for thirty minutes. Then remove the upper section containing the milk, cover it and cool it as rapidly as possible to about 45 degrees. Now keep the milk in a cool, clean place until it is to be used.

It is known that a temperature of 143 degrees F. for 30 minutes is high enough to kill any disease germs likely to have found their way into the milk. This temperature does little or no harm to the milk but makes it safe to use.

Assignment: 1. Visit a dairy to see how milk is pasteurized and cooled on a large scale.

THE CARE OF MILK FROM THE COW TO THE CONSUMER

Milk is one of the most difficult foods to keep clean and wholesome. By careless milking and handling, disease germs or bacteria may enter the milk from various sources. Having entered, bacteria find milk, especially when warm, to be a very favourable medium for their rapid growth and increase. They soon cause it to sour and may make it unsafe to use. Unsafe milk has caused tuberculosis, typhoid, diphtheria, dysentery, septic sore throat, undulant fever, whooping cough and other diseases.

Problem 4: How does milk become contaminated on the farm and in the home? What dirt commonly gets into milk on the farm? How does it affect the milk?

Method: (a) Set up an experiment using six test tubes and clean fresh milk. Leave No. 1 test tube dirty, but thoroughly wash and sterilize the other five with hot water. Fill all half-full of milk. Label the dirty tube No. 1, and to No. 2 add a few cow's hairs; to No. 3 add a few specks of cow manure; to No. 4 add a fly; and do not add anything to No. 5 and No. 6. Seal tubes 1–5 with plugs of cotton batting and leave No. 6 unsealed. Set the six prepared tubes aside in a warm place for careful observation to find which milk sours first, and which last. Keep a systematic record. Account for the difference in time it took the milk to turn sour.

(b) Explain how each of the following precautions on the farm helps to prevent the contamination of milk:

1. The stable—
    (a) keeping stable clean, free from flies, well ventilated
    (b) feeding after rather than before milking
2. The cows—
    (a) making sure cows are healthy (tuberculosis tests, etc.)
    (b) brushing flank and washing udder and teats before milking
3. The milker—
    (a) wearing clean clothes when milking
    (b) washing hands before milking
    (c) making sure that the milker is healthy and not a disease carrier
4. Utensils—
    (a) using clean sterilized utensils
5. Care of milk—
    (a) straining and cooling milk soon after milking
    (b) keeping milk covered

(c) Discuss the reasons for the following precautions needed in the home to prevent rapid deterioration of milk.

Buying pasteurized milk in tightly capped bottles
Taking in milk as soon as possible after delivery and washing cap and bottle before putting into the refrigerator
Not allowing milk to freeze
Washing milk pitchers thoroughly and frequently scalding them
Keeping milk covered

Enumerate observations you have made regarding carelessness and ignorance in the handling and care of milk.

Questions and Exercises:

1. How may milk become contaminated from the cow to the table?
2. Review ways of preventing contamination of milk.

References:

Dairying, Farm and Factory, Dean; Ryerson Press.
Ontario Department of Agriculture, Toronto
    Bulletin 370—*Testing Milk, Cream and Dairy By-Products*
Dominion Department of Agriculture, Ottawa
    Wartime Series No. 58—*Cooling Milk on the Farm*

Section Five . . . Poultry Keeping

- Characteristics of Common Breeds
- Classification of Common Breeds of Chickens
- The Parts of an Egg and Their Uses
- Egg Grading
- Incubation and Rearing of Chicks
- Winter Care of Poultry
- Feeding the Laying Flock
- True–False Test

SECTION FIVE
POULTRY KEEPING

Approach: Poultry keeping is a healthful occupation and is enjoyed by all who become interested. It requires little capital and brings quick returns, when compared with most other branches of farming. There is always a ready market for its products because the eggs and meat are wholesome food relished by most people. Poultry keeping, however, has its problems which must be studied in order to succeed well with the enterprise.

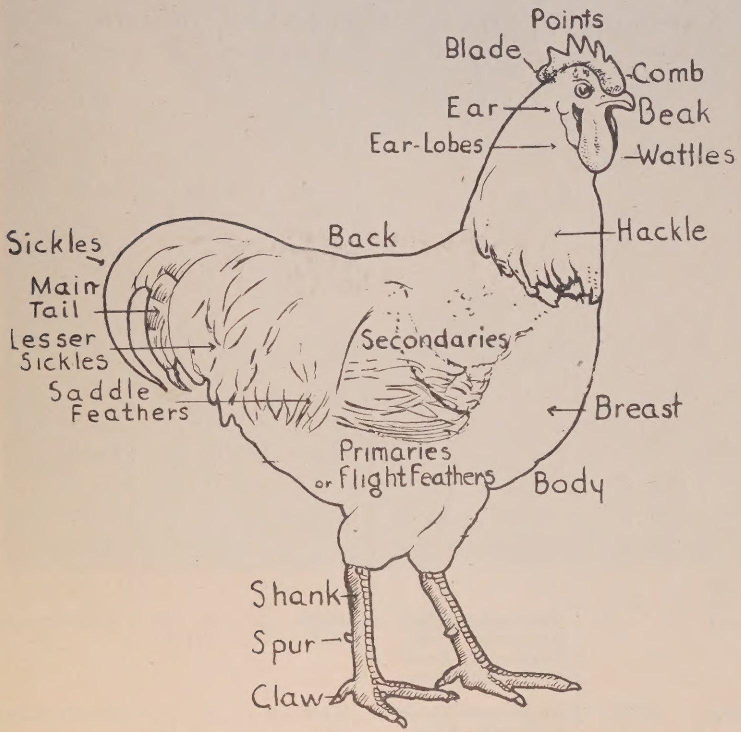

Points
Blade
Comb
Ear
Beak
Ear-Lobes
Wattles
Sickles
Back
Hackle
Main Tail
Lesser Sickles
Secondaries
Saddle Feathers
Breast
Primaries or Flight Feathers
Body
Shank
Spur
Claw

Fig. 33. Parts of a fowl.

Some important things to think about:

1. Why nearly all farmers keep poultry.
2. How to distinguish the different breeds.
3. How to classify the breeds.
4. The purpose of grading eggs and how it is done.
5. How to operate an incubator.
6. How to rear young chicks.

CHARACTERISTICS OF COMMON BREEDS

Name all the breeds of chickens you can identify. Which do you fancy? Which breed do you keep at home? Why?

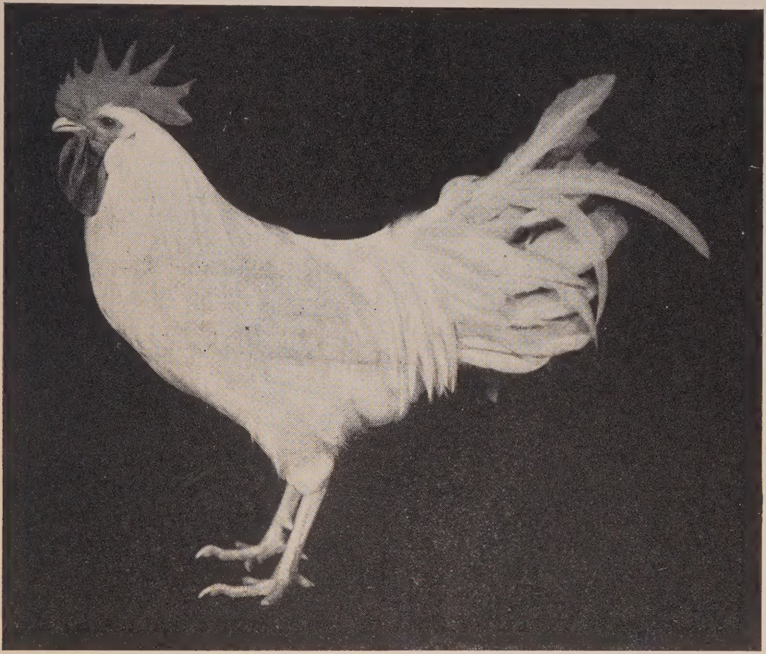
Problem 1: What are the characteristic features of six common breeds of chickens?

Method: With the aid of good pictures of breeds and with one or two live cocks or hens for comparison, study the relative size (small, medium, large), shape (slender, long, deep, thick), and note the colour of the earlobes and the shanks. Tabulate the findings.

CLASSIFICATION OF COMMON BREEDS OF CHICKENS

Types and Breeds	Varieties	Weight	Class (Origin)
General Purpose Type			
Plymouth Rocks	Barred White Buff	(Cock 9½ lb. (Hen 7½ lb.	American
Wyandottes	White Buff Columbian	(Cock 8½ lb. (Hen 6½ lb.	American
Rhode Island Reds	Rose-comb Single-comb	(Cock 8½ lb. (Hen 6½ lb.	American
New Hampshire	Single-comb	(Cock 8½ lb. (Hen 6½ lb.	American
Orpingtons	Buff White	(Cock 10 lb. (Hen 8 lb.	English
Sussex	Light	(Cock 9 lb. (Hen 7 lb.	English
Egg Type			
Leghorns	Single-comb White Rose-comb White Single-comb Brown Rose-comb Brown	(Cock 6 lb. (Hen 4½ lb.	Mediterranean
Minorcas	Single-comb Black Rose-comb Black	(Cock 9 lb. (Hen 7½ lb.	Mediterranean
Anconas	Mottled Black and White	(Cock 6 lb. (Hen 4½ lb.	Mediterranean
Meat Type			
Brahmas	Light Dark Buff	(Cock 11 lb. (Hen 8½ lb.	Asiatic
Langshans	Black White	(Cock 9½ lb. (Hen 7½ lb.	Asiatic
Cornish	Dark	(Cock 10 lb. (Hen 7½ lb.	English

Explanation: The different *breeds* are grouped into *classes* named after their place of origin. They differ from one another chiefly in shape, though also in size and colour. Each breed is subdivided into *varieties* based mainly on the colour or colour pattern of plumage and the kind of comb. From the economic standpoint breeds are grouped into *types* indicating their chief purpose or use, namely, the meat type noted for meat, the egg type noted for egg laying, and the general purpose or utility type satisfactory for both egg and meat production.



(*National Film Board, Ottawa*)

Fig. 34. White Leghorn Cockerel.

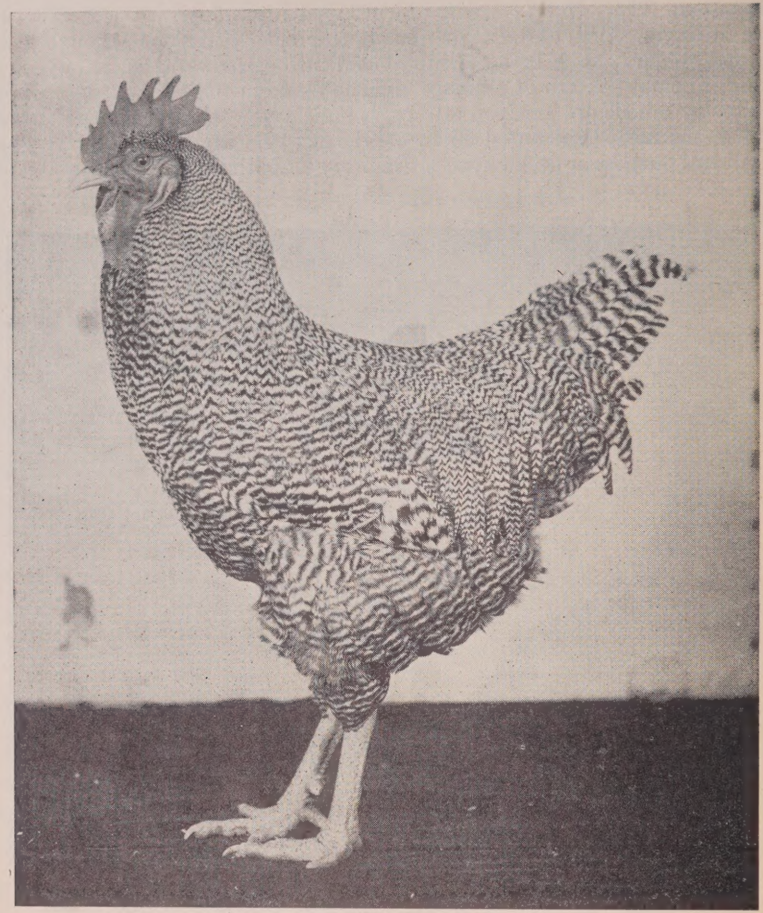
THE PARTS OF AN EGG AND THEIR USES

Approach: We are all interested in eggs because of their food value. The structure of an egg is also interesting because it includes everything needed for the development, under proper conditions of incubation, of a young chick. Name as many parts of an egg as you can.

Problem 2: To find the parts of an egg and to learn their uses.

Method: Carefully break an egg into a saucer for each group of pupils and let them examine the parts as directed. As the lesson proceeds build up a blackboard drawing of the parts.

Observe that the germinal disc or white germ spot is on the upper side of the yellow yolk. From the germinal disc the embryo chick develops during the



(National Film Board, Ottawa)

Fig. 35. Barred Plymouth Rock, Cockerel.

process of incubation. Why does the yolk of the egg not spread through the albumen or white part? The vitelline membrane surrounds and encloses the yolk and also keeps the germ spot in place. Find the cord-like chalazas at two opposite sides of the yolk. They are attached to the vitelline membrane and are more elastic than the surrounding albumen. They help to hold the yolk in suspension near the middle of the egg. But as the egg gets older the chalazas gradually lose their elasticity and the yolk rises because it is lighter than the albumen surrounding it. When a fresh egg is rotated the chalaza permits the yolk to twirl so that the side bearing the germ spot remains uppermost. The yolk turns in this way because the half which bears the germ spot is lighter than the other half. This explains why the germinal disc appeared on top when the content of the egg was carefully dropped into the saucer.

What is the nature and the use of the covering of the egg? Lining the inside of the shell are two tough membranes which serve as a protection to the soft inner parts and also give strength to the brittle limy shell. Observe the interior of the shell to see that at the broad or larger end of the egg the two membranes are separated and that there is an air space between them. In the newly laid egg this is quite small, but as the egg gets older the space enlarges, since the shell and membranes are porous enough to admit air and bacteria and also to allow the slow evaporation of water and the discharge of carbon dioxide from the interior. In incubation the air space provides the first supply of air needed by the young chick. If eggs are left too long in one position the air space may alter its position or shape.

What purposes do the yolk and the albumen serve during incubation? They contain the essential protein, fat, minerals and vitamins to serve as nourishment for the developing embryo. When these foods are nearly all used up, the chick is able to chip the shell and push its way out.

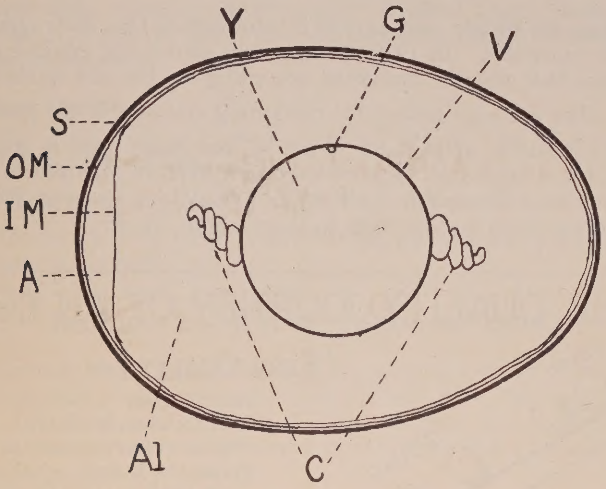


Fig. 36. Parts of an egg.

A—air cell. Al—albumen. C—chalazas. V—vitelline membrane. G—germ spot. Y—yolk. S—shell. OM—outer membrane. IM—inner membrane.

Note the advantage of the arch-like shape of the shell. This adds strength against external force or pressure. A hard-shelled egg held between the clasped hands with the ends in the hollow of the hands may be subjected to considerable pressure without breaking. Why are eggs for shipment packed with the small end down?

Since an egg contains a fair balance of protein, fat, vitamins, and the minerals phosphorus, iron, calcium, needed in our diet, it is considered to be, next to milk, nature's most nearly perfect food.

Questions and Exercises:

1. Make a drawing of an egg and name the parts represented.
2. Explain the uses of the parts of the egg.
3. Why does the air space get larger during the process of incubation, or as eggs are stored in a warm room?
4. Explain why eggs should be packed with the small end down.
5. Why are eggs very useful as food?
6. Try an experiment to show that the yolk of an egg is lighter than the albumen.

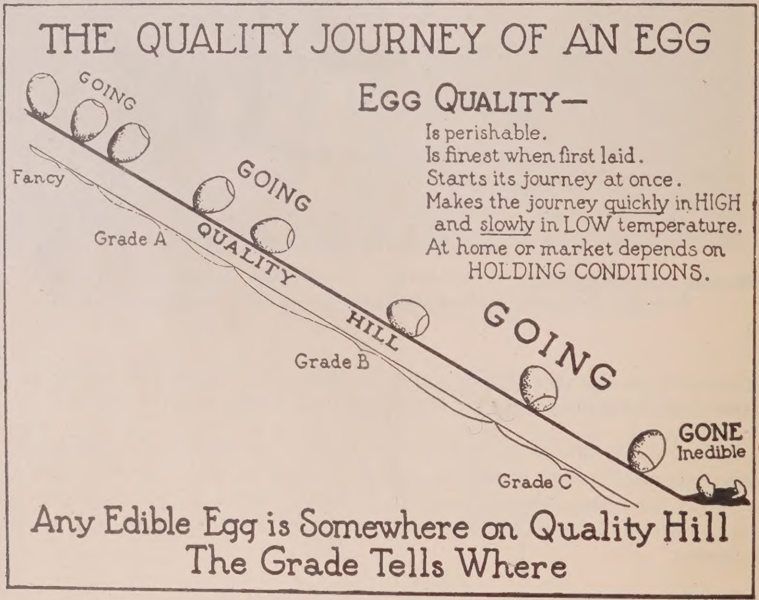
Mark two or three fresh eggs with a cross on one side of each and lay them away with the cross uppermost for three or four weeks. Then hard boil them in this position and cut them across to discover which way the yolk moved.

EGG GRADING

Since eggs are widely used as food it is important that their quality should be carefully controlled. In 1920, Canada introduced egg grading regulations which require that eggs be marketed according to size and quality.

Problem 3: Why are eggs graded for marketing and how is the grading done?

Method: (a) External appearance is one of the bases used in grading eggs. Compare a dozen unselected eggs with a dozen that are all uniform in size and colour, and clean and sound in shell. Which would you choose? When buying eggs what other facts do you wish to know about them?


THE QUALITY JOURNEY OF AN EGG
GOING
Fancy
GOING
Grade A
QUALITY
HILL
Grade B
GOING
GONE
Inedible
Grade C
EGG QUALITY—
Is perishable.
Is finest when first laid.
Starts its journey at once.
Makes the journey quickly in HIGH and slowly in LOW temperature.
At home or market depends on HOLDING CONDITIONS.
Any Edible Egg is Somewhere on Quality Hill
The Grade Tells Where

(Courtesy, Farmer's Advocate)

Fig. 37. Changes in egg quality.

(b) Interior quality as determined by candling is also used in grading. A simple egg-candling apparatus can be made by fitting a small box over a lamp and cutting a hole a little smaller than an egg in one side at the level of the flame or filament. Have on hand a dozen eggs, some good and some bad. Darken the room and hold each egg close to the opening so that the light illuminates the larger end of the egg. Twirl the egg slowly and carefully, observing:

(i) The size and position of the air cell.
(ii) The dimness, shape and position of the yolk shadow.
(iii) The presence or absence of blood clots or blood rings.
(iv) The presence or absence of meat spots.
The presence of meat spots lowers the grade to "C."

(c) In Dominion Regulations, *The Grading and Marking of Eggs*, find the requirements of interior quality, size (weight), cleanliness, and soundness of shell for each of the following market grades: Grade A Large, Grade A Medium, Grade A Pullets, Grade B, Grade C. Compare the current market price in your locality for each grade.

Questions and Exercises:

1. Put a stale egg and a fresh egg into a large bowl of water. Account for the difference in results.
2. Explain why egg grading is beneficial to (i) the buyer, (ii) the producer.
3. Discuss the relationship between egg grading regulations and the proper care of eggs.

INCUBATION AND REARING OF CHICKS

The natural method of incubation and rearing a brood of chicks is to set a broody hen with 13–15 eggs and to care for her. After the chicks are hatched she looks after them until they are able to take care of themselves. The artificial method is to operate an incubator for hatching and a brooder for rearing. Which is the commoner practice?

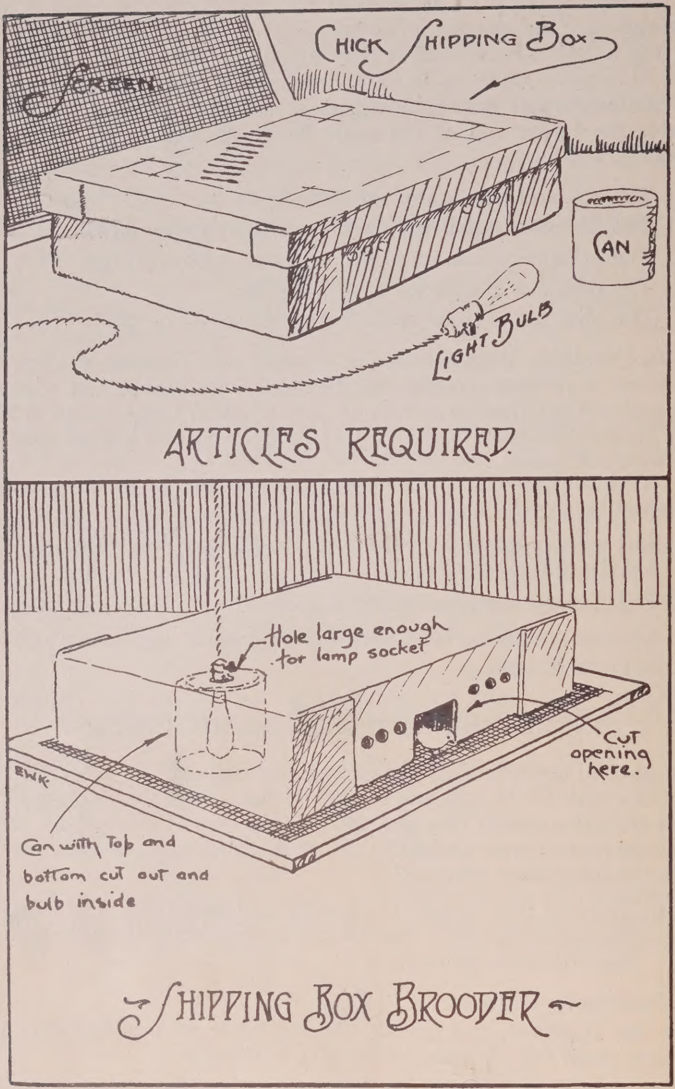
Problem 4: To learn how to hatch eggs with an incubator and how to care for the baby chicks. (Operation of an incubator is optional in Public and Separate Schools.)

(*a*) *Incubating Activities*

Plan the activities, and operate the incubator as a co-operative project, having each pupil take a share in carrying it through.

Select eggs from a well-bred flock which has been given proper care. Observations in the subsequent candling are more easily made if white eggs are used. Clean the incubator thoroughly. Test the accuracy of the thermometer with another thermometer. Place both in a vessel of water at a temperature between 90 and 103 degrees F. A difference of more than one degree suggests the need of further checking.

Follow the manufacturer's directions for operating your machine. Set the incubator where it is free from draughts and regulate the temperature at 100–103 degrees F. by adjusting the thermostat and size of the flame before


Chick Shipping Box
Screen
Can
Light Bulb
ARTICLES REQUIRED
Hole large enough for lamp socket
Cut opening here.
EWK
Can with Top and bottom cut out and bulb inside
SHIPPING BOX BROODER

(*Ontario Dept. of Agriculture*)

Fig. 38. Shipping-box brooder, heated with 40-watt bulb.

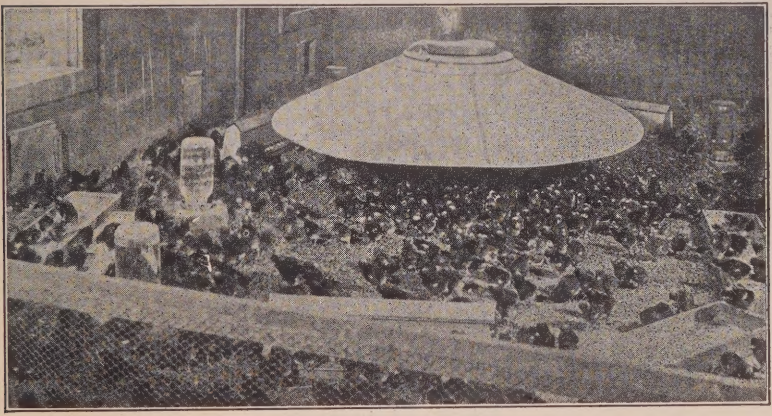
putting in the eggs. Make a chart for keeping systematic records of daily activities. Keep a large, shallow pan of water under the egg tray to regulate the humidity. The humidity should test over 60%.

Turn the eggs twice daily, morning and evening, from the third day until the eggs begin to pip. During the course of the incubation adjust the ventilators to admit more air. Trim the lamp and replenish with oil daily, taking care to avoid any contact of eggs with the oil or with oily hands. An electric heating element may replace the lamp. Candle the eggs about the seventh day to remove infertile eggs and dead germs. Also candle again about the 15th day to remove dead embryos and so leave more room for the hatching chicks.

By the twenty-first day the brooder should be ready and the thermostat adjusted to maintain a temperature of 97–100 degrees F. Transfer the strong dry chicks to it for further care. At no time allow the chicks to become chilled.

Questions and Exercises:

1. What may cause the lamp of an incubator to smoke?
2. Explain how a uniform temperature of 100–103 degrees F. is maintained.
3. Explain why a high humidity in the egg chamber is beneficial.
4. Why should eggs be turned at least twice daily at regular intervals from the third day to the eighteenth day of the hatch?
5. What other means, besides the coal oil lamp can be used for heating the egg chamber of an incubator?



(Ontario Dept. of Agriculture)

Fig. 39. Coal-burning brooder.

(*b*) *Brooding Activities*

Place the chicks from the incubator or from a baby chick shipping box in the brooder or hover at 97–100 degrees F. Avoid the following: chilling, overheating, overcrowding, poor ventilation, draughts, filth, improper feeding, lack of light, inadequate supply of clean, lukewarm water.

After the first week lower the temperature at the rate of 5 degrees per week until a temperature of 75 degrees is reached. Perhaps after the sixth week no more heating may be necessary. If the chicks huddle together to keep warm, the temperature is too low. More chicks are lost by sudden changes in temperature and chilling than by any other cause.

As soon as the chicks have been put in the brooder, supply them with plenty of lukewarm water in a drinking fountain before they are fed. As a first feeding, scatter dry commercial "chick starter" on sheets of paper or boards and to this add a sprinkling of coarse sand, or oyster-shell grit. Later, supply the dry "chick starter" and the grit in separate feeding troughs. Keep feed, grit and water before the chicks continually that they may eat and drink whenever they wish. In addition a supply of some green feed is desirable. Shoots of sprouted oats two inches long, or tender grass finely cut, will do. Continue feeding in this way for six weeks. However, after three weeks a fine cracked-grain mixture may be added to the ration.

A fairly good home-made feed for starting chicks is a mixture of dried bread crumbs, oatmeal and hard-boiled eggs, especially the yolks, grated fine. In addition supply all the skimmilk or buttermilk the chicks will drink. These feeds will take the place of commercial "chick starter," if it is not available.

Commercial chick feeds usually contain about equal parts of yellow corn meal, wheat bran, flour middlings, pulverized hulled oats, dry meat scrap and 5% of dried skimmilk or buttermilk, oyster-shell meal and natural cod-liver oil. They also contain less than 1% of iodized salt. They are intended to supply the proper amounts of proteins, carbohydrates, minerals and vitamins for healthy growth.

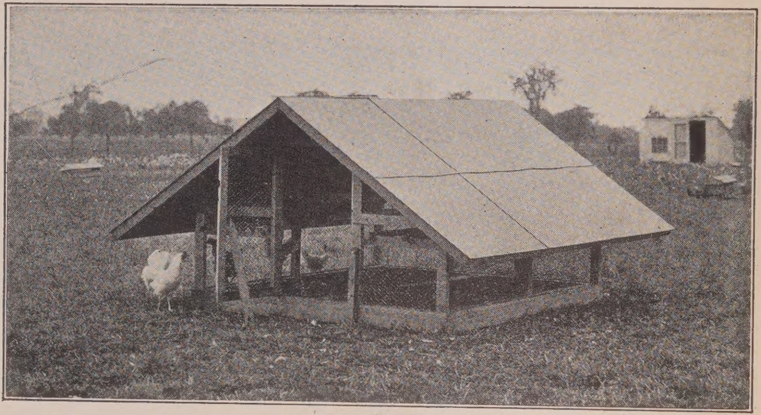


Fig. 40. Range shelter. *(Ontario Dept. of Agriculture)*

(*c*) *Housing and Feeding on the Range*

When chicks are fairly well feathered and the weather is warm enough, they should be transferred to a shelter on a clean range which provides plenty of roosting space, fresh air and protection from rain. On the range they will find their own green feed, and get plenty of sunlight and exercise. Perhaps, too, they may catch enough insects and worms to supply their protein needs. The keeper, however, must provide a dry mash for growing chicks, a grain mixture, and plenty of clean water.

Questions and Exercises:

1. Explain how the artificial brooder takes the place of the mother hen.
2. Visit a commercial hatchery to see how the hatching is done and how the chicks are cared for.
3. Why can day-old chicks be expressed long distances?
4. Explain why chicks need grit or oyster shell.
5. Describe the construction of a range shelter.

WINTER CARE OF POULTRY

The purpose of keeping poultry is the production of eggs and meat. The enterprise will not succeed unless the flock is well housed and fed, for a neglected flock soon loses its health and vigour and will produce few eggs and little meat.

Problem: What are the requirements for satisfactory winter housing of chickens to secure high egg production?

This problem requires an investigation of:

(a) The location of the house for dryness and for protection against prevailing winds.

(b) The type of roof and the kind of walls and floor.

(c) Provision for lighting and ventilation.

(d) Location of roosts, dropping-boards and nesting quarters.

(e) The kind of feeding hoppers and drinking fountain.

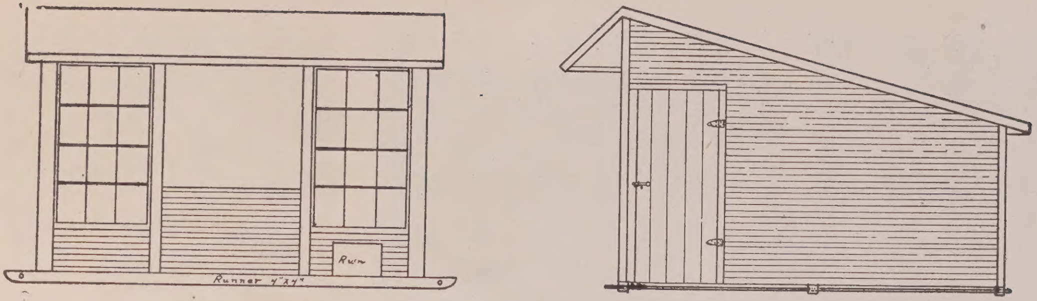
(f) Sanitary conditions and control of lice.

An excellent way to have a class study these features is to visit a good poultry house and there observe them. On returning to the classroom review the observations and discuss reasons. Stress the type of poultry house adapted to the locality. In villages most pupils can be easily interested in properly housing the small flocks. Where larger flocks are kept, deal more especially with the larger type of poultry house. As the review proceeds build up a simple board summary of concepts or ideas. For notebook work assign pupils a few definite questions to answer which deal with the important concepts. Merely copying a board summary to learn has little educational value.

Housing: In Ontario the three general types of chicken houses are the colony or single section house; the long or multiple section house consisting of two or more pens; and the two or three-story house, with multiple section pens on each floor. To house a flock of 25 to 75 hens the single section house is used; but for larger flocks, either the long or the multiple story house is more economical.

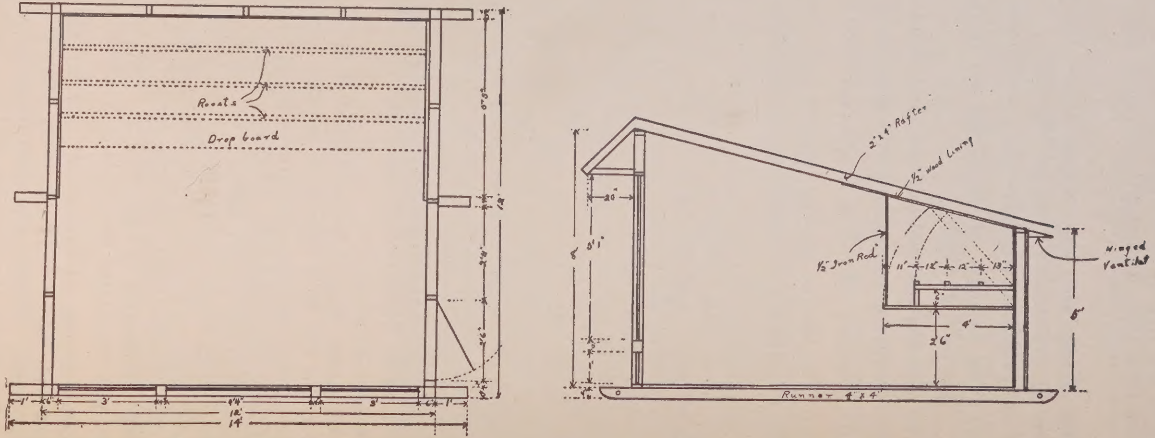
Whatever kind of house is used, it must provide adequate protection and comfort for the flock during all seasons of the year. Coolness in summer and freedom from draughts and frost during the winter, and adequate ventilation at all times are essential. Chickens have a relatively high body temperature ranging from 105 to 107 degrees F., but a temperature of about 50 degrees F. in the poultry house during the winter months has been shown to be favourable. Experiments conducted at the Ontario Agricultural College over a period of five years showed that, with the same breed of hens and the same feeding, the average production of eggs for the winter months was 11.1 per cent higher in a cool well-ventilated house than in a warmer house with less fresh air.

The colony house: A favourable size for the single house is 12 feet long by 12 feet wide and 8 feet high at the front or southern exposure and 5 feet high at the back. This construction demands a shed roof. Allowing four square feet for each hen, it will accommodate a flock of 36. The upper half of the front or southern wall carries the windows and these should occupy about one-third of the total front wall space. In order to admit sufficient light and provide adequate ventilation, half of the window openings should be glass and the other


Run
Runner 4"x4"

Front Elevation

End Elevation


Roosts
Drop board
1'
6"
3'
4'4"
3'
6"
1'
12'
14'
6'0"
12'
2'4"
2'6"
2"x4" Rafter
½" Wood Lining
½" Iron Rod
11"
12"
12"
13"
2"
4'
2'6"
Hinged Ventilator
6'
20"
8'
5'1"
1'
Runner 4"x4"

Floor Plan

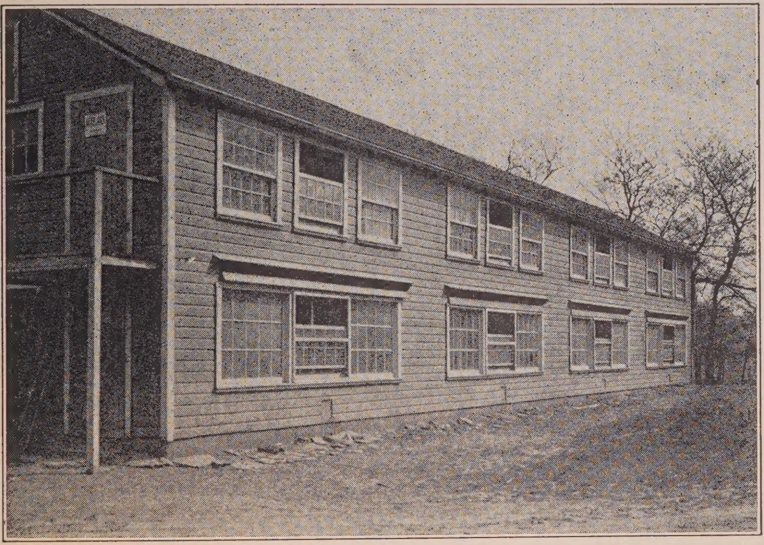
Cross Section

(Ontario Dept. of Agriculture)

Fig. 41. Plan, elevation and cross-section of 12 x12 colony house.

half factory cotton, muslin, or thin burlap. If the window space is all glass, then provision should be made to allow every second window to be opened at the top. The sash should be hinged at the bottom and a cord at the top should allow the frame to open inwards. This type of window has been recommended by the poultry department of the Ontario Agricultural College as satisfactory for lighting and for providing ventilation free from draughts.

The open-front house: In the warmer sections of Ontario the open-front house, 20 feet square, is favoured for the small flock. The front, or south side is low and screened with wire netting from the base board to the roof to keep the chickens in, and the sparrows and other enemies out. The low front and the gable roof with its protecting edge give adequate protection against rain, snow and wind. To provide additional light a large window is built in the middle of the west wall. This window is constructed so that it can be easily opened during the summer to increase ventilation and keep the house cool.



(Ontario Dept. of Agriculture)

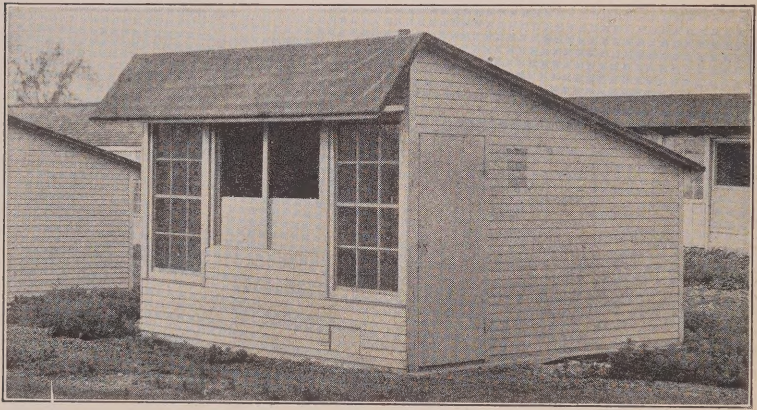
Fig. 42. Double-deck poultry house.

Requisites for Any Type of House:

(a) *Dryness:* To secure dryness, particular attention needs to be paid to the location of the hen house and also to the kind of floor, the drainage and the ventilation. Floors are made of concrete or wood. Concrete flooring is more durable, easier to keep clean, and affords better protection against rats, mice and weasels. The wooden floor should be made of two layers of boards, with tar paper in between to keep it dry and free from draughts. The advantage of the wooden floor is that a small house can be moved readily from one location to another. Usually the cost of the construction of the two floors is about the same. The best ceiling is made of slats covered with straw under the roof. This absorbs moisture and helps to keep the temperature more uniform. The small poultry house however, with plenty of space and good ventilation for 25–50 hens, may be dry enough without a slatted ceiling and straw loft.

(b) *Ventilation:* Sufficient and uniform ventilation is another absolute necessity to be considered in the construction of a hen house. The body of the fowl is not provided with sweat glands, and consequently the exhaled breath of fowl is heavily laden with moisture and impurities from the body processes. If the ventilation is not adequate, the air will become impure and too moist, and in freezing weather moisture may cause the walls, windows, ceiling, and even the litter on the floor to become covered with frost. These conditions are undesirable. Insulation of side walls is valuable for cold weather.

Proper ventilation is secured by windows and window openings placed in the upper half of the south or front wall. The openings, with an area of 1 sq. foot for each 20 sq. feet of floor space, should be screened with cotton or muslin and adjustable according to weather conditions. In larger houses it may also be necessary to have a centrally located shaft extending through the roof. The ventilating system should distribute fresh air equally throughout the house and should not create draughts along the floor or around the roosts. Draughty conditions will cause colds, rheumatism, roup and other similar ailments.



(*Ontario Dept. of Agriculture*)

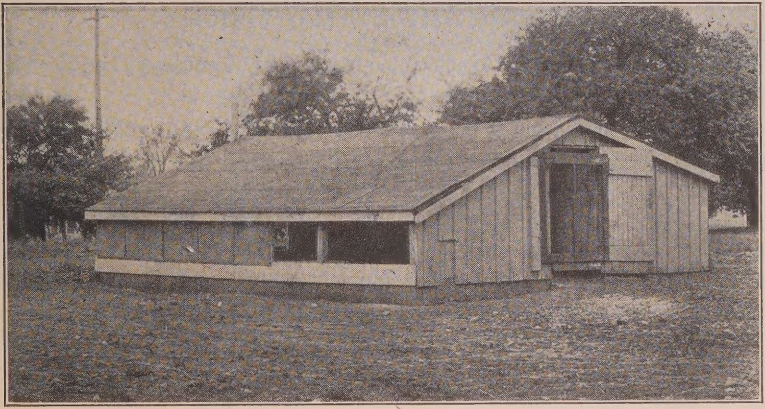
Fig. 43. Colony House, 12 x 12 feet.

(c) *Lighting:* Sunlight is also necessary in the poultry house to keep the conditions sanitary and the flock active. Without sufficient sunlight the chickens are likely to develop lameness or rickets unless their ration contains cod-liver oil or plenty of whole milk.

To secure sufficient lighting there should be not less than 1 sq. ft. of window glass in the upper part of the south wall for every 20 sq. ft. of floor space. An additional screened opening of equal area is needed for satisfactory ventilation. The windows, of course, are rectangular and placed in an upright position in order that the sun's rays may be distributed over the whole floor from west to east during the course of the day. Some poultrymen favour small windows in the back as well as the large ones in the front. They provide 1 sq. ft. of glass in the rear wall to every 3 sq. ft. in the front wall.

A coat of whitewash on the walls and ceiling improves the reflection of light throughout the whole house. The use of electric light, morning and evening, during the short days of winter has been found to keep the flock active longer and to give a larger egg production.

(d) *Equipment and Sanitation:* To provide the maximum amount of space for the straw litter and for the exercise of the flock, all fixtures should be supported off the floor. Sufficient roosts to avoid crowding are placed along the back wall of the house and about three feet off the floor where no draughts strike the birds while roosting. The dropping-boards should be built six to ten inches beneath the roosts. It is important that these be kept clean and sanitary. At least one nest for every six laying hens should be provided in rows along the wall and off the floor. Sometimes they are built under the dropping-boards. Where a record of performance is kept, trap nests are used. It is important to keep the nesting material clean to have clean eggs. Feeding hoppers and drinking pans may be hung on the wall within easy reach of the hens, or they may be set on the floor. The floor should be kept covered with a clean litter of straw three or four inches deep.



(*Ontario Dept. of Agriculture*)

Fig. 44. Open-front house, 20 x 20 feet.

Dropping pits are replacing dropping boards to a large extent in many of the poultry plants of this province. The pits are usually cleaned every month or two months. The manure in the pit is treated daily with superphosphate at the rate of one to two pounds to one hundred birds. Hydrated lime may be used in place of the phosphate and is more effective as a deodorant.

Built up litter is second only to the dropping pit as a labour-saving device. When pullets are put in their winter quarters four to six inches of litter are put on the floor. More is added when this becomes soiled. This litter is usually removed twice a year. The deep litter also acts as insulation against the cold floor.

(e) *Storage:* Satisfactory poultry management of large flocks requires a place where the feeds can be stored in bins and measured and mixed ready for feeding. Such a place needs to be proof against rats and mice, or serious losses may be expected. A storage room for eggs is also an essential. Eggs should be gathered twice daily and stored where the air is cool, dry and free from dust and odours. Here they may be candled and graded at leisure.

(f) *Prevention of Lice:* Keeping the poultry house clean helps greatly to prevent lice. Should the flock become infested the birds lose weight and vigour and the egg production goes down. To remedy this condition the birds should be treated with commercial sodium fluoride to kill the parasites. The sodium fluoride should be mixed with four times its bulk of flour and the mixture put into a shaker. Ruffle the feathers of the birds and then dust the mixture well into the feathers. The application may need to be repeated in about two weeks.

FEEDING THE LAYING FLOCK

It is known that certain kinds of feeds regularly fed cause the laying flock to produce more and better eggs.

Elicit from pupils what is being fed at home to their laying hens and when.

Problem: What are the winter feeding requirements of the laying flock?

The winter-laying flock requires a balanced ration of whole grain, mash, green feeds, and plenty of clean water. These materials must be supplemented by supplies of grit, oyster shell and charcoal. The main part of the feed is supplied by the mash and the whole grain. Regularity in feeding is important.

There are various dry mash mixtures which may be purchased at feed stores. The Ontario Agricultural College Poultry Department recommends a mixture made up of:

750 lb. corn chop
500 lb. shorts
500 lb. oat chop
500 lb. low grade flour
300 lb. bran
6% high grade tankage

This last ingredient supplies necessary protein and phosphorus. The mixture may be placed dry in the hoppers so that it is available at all times. A wet mash mixed with whole, skim, sour or buttermilk should be provided as a supplementary feeding. At the Iowa Experimental Station it was found that hens given buttermilk in addition to whole grain, mash and tankage laid more eggs than did those not given any buttermilk.

The whole grain or scratch mixture often consists of equal parts of yellow corn and good wheat, to which may be added small quantities of barley, buckwheat and plump oats. This mixture may be scattered in the clean litter on the floor in the late afternoon. In this way the birds will get a useful amount of exercise and will go to roost with their crops filled with a feed that takes longer to digest than mash feeds. Where the litter is not kept clean it is well to feed the grain in separate hoppers to avoid contaminating it by the droppings of the birds in the litter on the floor.

In addition to the mash and whole grain feeds which should ordinarily make up about 85 per cent of the daily ration, the flock requires some green and succulent feeds consisting of cabbage, mangels, beets, apples, alfalfa or sprouted oats. These supply water, mineral matter, protein, fibre and vitamins, all of which are necessary to regulate digestion and maintain the flock in a healthy, productive condition. If the cabbage or root vegetables are hung up so that the hens will have to jump to reach them, exercise as well as food will be provided.

Whatever method of feeding is employed, grit, oyster shell, charcoal and water should be accessible to hens at all times. Grit in the gizzard takes the place of teeth for grinding food and also supplies mineral matter. Oyster shell supplies lime which the laying hen needs for making egg shells. Charcoal should be given to hens to absorb gases which frequently form in their digestive tract. Plenty of clean water is very necessary for regulating body temperature and for the normal functioning of the body processes of fowl. This is apparent when you consider that new laid eggs are approximately 63.9 per cent water and that the body of the fowl is 59 per cent water.

If there is not abundant sunshine in the poultry house during the winter' one-half cupful of cod liver oil should be mixed daily in the mash for every hundred hens. It is needed to supply vitamins A and D, for growth and good bone formation.

Good laying breeds, if properly fed and housed, will average 200 eggs per hen per year; while, if poorly cared for, they will produce only an average of about 60 eggs per hen per year. A White Leghorn which was owned by the University of British Columbia in 1929 produced 351 eggs in a year.

Board Summary:

Feeding the Winter Laying Flock

1. To keep flock healthy and laying well feed regularly and liberally.
2. Balanced ration consisting of:
   (a) Dry mash mixture fed in hoppers.
   (b) Whole grain mixture of yellow corn, wheat and a little barley, buckwheat and oats, fed in the evening.
   (c) Supplementary feeds: milk and milk products, kitchen scraps.
   (d) Green or succulent feeds: cabbage, mangels, alfalfa, apples. They tend to keep the digestive tract healthy.
   (e) Special mineral matter: grit for grinding in the gizzard, oyster shell for making egg shells, charcoal for absorbing gases.
   (f) Plenty of clean water to drink at all times.
3. Wrong and insufficient feeding greatly reduces egg production.

Notebook Exercises

1. Describe the location of a poultry house for a small laying flock.
2. Explain why poultry need plenty of sunlight and proper ventilation free from draughts.
3. Describe the nesting and the roosting requirements.
4. What would you do to get rid of lice on an infected flock?
5. Classify the ration of the laying flock.

6. Why does the flock need grit, oyster shell, succulent feeds and plenty of clear water?
7. In an enterprise of housing and feeding 30 or 50 laying hens, describe the type of house you would provide and tell what and how you would feed them.

Problem 5: What are the reasons for the popularity of poultry-keeping on the farms as a side line?

Method: Arrange a panel discussion of three pupils to discuss before the class some of the topics listed below (see p.126).

(a) The outlay of capital and labour required compared with other side lines.
(b) The consumption of waste matter on the farms.
(c) The convenience of eggs and poultry meat for home consumption.
(d) The importance of eggs and poultry meat in a diet.
(e) Income from cash sales.
(f) Why the well-bred and properly managed flock is the most productive.
(g) Why chickens are the most popular kind of poultry.

TRUE-FALSE TEST

Directions: Put "T" before each true statement and "F" before each false statement. Do not guess.

1. Leghorn chickens belong to the general purpose type.
2. Wyandotte chickens had their origin in the United States.
3. Minorcas are black with large white ear lobes.
4. Mature Plymouth Rocks are heavier than mature Rhode Island Reds.
5. Varieties of White and Brown Leghorns may be either single-combed or rose-combed.
6. A stale egg sinks in water and a fresh egg floats.
7. The air cell in an egg is between the shell and the outer membrane.
8. The presence of a meat spot in any egg lowers the grade to B.
9. A grade A egg shows the outline of the yolk distinctly when candled.
10. Egg grading is beneficial to both the producer and the buyer.
11. In candling an egg it should be held at the large end so the air cell can be readily seen.
12. It is easier to candle white-shelled eggs than brown-shelled eggs.
13. In artificial incubation the temperature is maintained at 100 degrees F. by regulating the ventilation.
14. An incubation project at school develops interest, co-operation and responsibility.
15. The humidity of the egg chamber is maintained by a large shallow pan of water under the egg tray.
16. Hen's eggs hatch in thirty-one days.
17. Day-old chicks do not stand shipping as well as those a week old.

18. As soon as chicks will eat they should be fed a "growing mash," grit and lukewarm water.

19. More chicks are lost by sudden changes in temperature and chilling than by any other cause.

20. In a range shelter the chicks roost on the ground.

21. Chickens are the most common kind of poultry kept on the farm.

22. Good eggs, next to milk, are our most nearly perfect food.

References:

Ontario Department of Agriculture, Toronto
  Bulletin 395—*Farm Poultry*
  Bulletin 428—*Poultry Equipment for the Busy Farmer*
  Bulletin 446—*Eggs: the production, identification and retention of quality.*

Dominion Department of Agriculture, Ottawa:
  Publication 541—*Poultry Feeds and Feeding*
  Regulations—*The Grading and Marking of Eggs*

Section Six . . . Gardening

- Educational Value of School Gardening
- The School Garden
  - The Hotbed
  - The Cold Frame
  - Indoor Flats
  - Bulbs for Flowers
  - Making a Perennial Border
- Growing Fruit Trees and Bush Fruits
  - Fruit Trees
  - Bush Fruits
- Growing Strawberries
- Growing Rhubarb
- Harvesting and Storing Vegetables
  - Harvesting
  - Storage
- Control of Insects and Weeds by Conservation of Birds
  - Feeding Habits of Birds
  - Bird Protection

SECTION SIX
GARDENING

Gardening means that comparatively large quantities of vegetables or flowers are raised on small tracts of land by intensive cultivation. The purposes are to grow vegetables or flowers for home use, for marketing, for canning factories, for seed production, for recreation. Truck gardens are commonly located near cities or in densely populated areas because there must be ready markets for the perishable vegetables.

EDUCATIONAL VALUE OF SCHOOL GARDENING

John Dewey, one of the outstanding educationists of our time, regards first-hand contact with the soil, through school and home gardening, as one of the real bases of education. Gardening activities develop worthy traits of character, and useful knowledge and skill. They awaken in boys and girls an interest in the wonders of nature and in the observation of the relationship of cause and effect. Making garden plans and carrying them out in co-operation with others affords training in social living, which is an essential factor in a democracy. Throughout the enterprise the methods and management of the good teacher stimulate initiative, thoughtfulness, patience, habits of industry and respect for labour. All of these are desirable outcomes of school work.

In the school garden the children need to be shown how to carry out the simplest activities such as levelling the ground, raking, measuring, making drills, dropping seeds, covering, firming the soil over the seeds, transplanting, mulching, weeding, thinning and spraying. The instruction and practice in doing these things with a purpose should be made experiences of pleasure and not drudgery. Then pupils will feel that the work is really a meaningful art and science to be both learned and enjoyed.

Regard the school garden as a beginner's laboratory, and do not make it larger than can be well cared for. The experience and inspiration which it affords should stimulate a desire to have home gardens. There each pupil can have larger responsibilities and exercise self-reliance. Plan, however, to make the home gardening a desirable link between the school and the home by your interest and visitation. It is to be hoped that the school experience may cause thousands to catch the spirit of gardening and make the activity a life-long hobby, which gives meaning, richness and colour to living.

THE SCHOOL GARDEN

Enterprise 1: Planning and preparing a school or home garden.

Selecting the Site: Avoid shady places and select a southern or southeast slope rather than a northern, for it receives longer hours of sunlight and more heat during the early gardening months.

Planning the Layout: Measure the area and find the number of square feet available for each class or for individual pupils. Then divide it accordingly and draw a plan to a suitable scale showing the area of plots and the width of paths. (See illustration p. 94.)

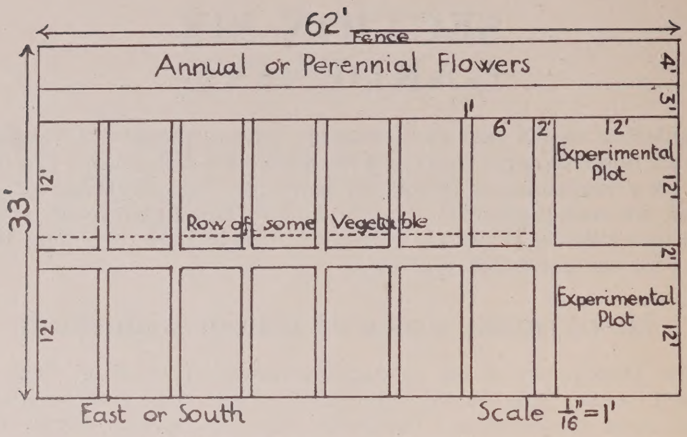


Fig. 45. Suggested garden plan.

Preparing the Soil: If manure has not been applied in the fall and ploughed in, it should be applied in the spring before ploughing or digging. Why does the soil need manure? In case there is plenty of organic matter (humus) in the soil, an application, after ploughing, of a complete fertilizer at the rate of 5 pounds to the square rod will be beneficial. It is well to test the soil for acidity. If it is acid or sour how can this condition be corrected? All ploughing, levelling and raking should be done when the soil is not sticky. Why?

Selecting Seed: Get catalogues from reputable seed houses. They usually contain valuable suggestions and directions. After choosing what you wish to plant, calculate the quantity of each kind of seed to be purchased, according to the number and length of the rows to be planted. Some of the seeds such as cabbage, tomatoes, peppers, cauliflower and some annual flowers need to be started in the hotbed or in indoor flats in March, to be ready for transplanting into the garden when it is ready.

Planting: Plant the rows of vegetables and flowers the whole length or width of the area or the individual subdivisions as indicated in the illustration. Run the rows north and south and keep them straight by using a line stretched from end to end or use a long straight-edge (board). Allow sufficient space between the rows for cultivation and sunlight. With the corner of the hoe or the end of its handle make the groove in which the seeds are to be placed. The depth as a rule is about four times the thickness of the seed. In light and in dry soils plant a little deeper than in heavy moist soils. Be careful to drop the seeds evenly along the rows without waste. It is well to plant a few radish seeds with small slow-germinating seeds such as onion, carrot, salsify and parsnip. The strong-growing radishes break the crust of the soil and mark the rows for early cultivation between the rows. After planting seeds, cover them with fine soil and always firm it over the seeds to keep them in place and to bring moisture to them.

Replanting: Sometimes replanting is necessary owing to poor seed, improper planting, or unfavourable weather. Seeds to be used for replanting should be soaked in lukewarm water for a few hours. This will cause them to germinate more quickly.

Transplanting: Plants started in the hotbed and cold frame, or in flats, are ready to transplant after the second pair of leaves has developed. A couple of hours before lifting, water them well. This fills the plants with water and causes the soil to stick better to the roots. Transplanting should be done on a cloudy day or late in the afternoon, and the roots should be exposed to the air as little as possible. Why?

To set the plants make holes with a dibble, or with your finger, large enough and deep enough that the plant can be set a little deeper in the soil than formerly, without bending the root. Gently pack the soil around the roots to leave no air pockets. If the soil is fairly dry, water each plant and mulch around it with dry soil. The distance to leave between the rows and the space between the plants in the row depends upon the growing habit of the plants which are being transplanted.

THE HOTBED

Enterprise 2: Preparing and caring for a hotbed.

Location: Locate the hotbed where there is good drainage, a convenient supply of water, plenty of sunlight and adequate protection from the cold north and west winds. Favourable places are on the south or southeast side of buildings or hedges.

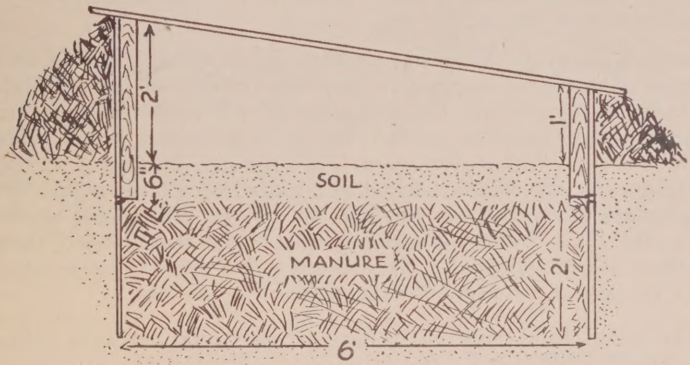


Fig. 46. Hotbed.

Making the Hotbed: (a) In the fall dig a pit six feet wide, between one and two feet deep, and any desired length east and west to give the capacity you need.

(b) In the spring fill the pit with fresh horse manure that has begun to heat, and tramp it down. Poultry or sheep manure may also be used, but not cow manure, because it will not ferment to produce sufficient heat.

(c) On top of the manure set the wooden frame so that the glass cover will slope to the south.

If it is necessary to make the frame, at each of the four corners use pieces of cedar scantling, 2 by 4 inches, as posts, and to these nail the walls of inch lumber. For convenience use boards about 12 inches wide. To provide for a sloping roof make the north side about one foot higher than the south side. The roof or cover consists of sashes fitted with window glass. The frame may be made to fit storm windows that can be removed from the house early in the spring from windows with a southern exposure. Arrange the construction so that the sashes may be partly opened for ventilation and entirely removed during warm weather.

(d) After the manure and frame are in place, put five or six inches of well-sifted rich garden soil (sandy loam) on top of the manure and level it. Then cover with the sash and leave the bed until the heat from the manure warms up the soil. When the temperature within, as indicated by a thermometer, remains fairly steady at 80–90 degrees F. the hotbed is ready for planting the seed.

If it is not convenient to dig a pit, construct a temporary hotbed on top of the ground. To do this, make the manure base two feet high when well packed down, and six inches longer and wider than the size of the frame which is to be placed on top of the manure. Board in the sides of the manure base to help keep in the heat. For this kind of hotbed it is often advisable to cover the selected location with manure in the fall to keep the frost out of the ground.

Planting the Hotbed: Use only choice seed and plant to a depth four times the diameter of the seed. With the edge of a board make narrow grooves of the proper depth four inches apart and running north and south. Drop the seed evenly along the grooves so there may be two or three seeds per inch; cover them with soil, and press the surface down with a board. Label each row with the name and variety of the seed sown.

Caring for the Hotbed: (a) Watering, ventilating, mulching, thinning, and transplanting are all necessary activities. Carefully sprinkle the bed with lukewarm water to keep the soil moist. Dashing on water will wash the seeds out before they germinate and take root. After the seedlings appear, water thoroughly, two or three times a week, before noon. Soak the soil, and permit the plants to dry off during the day before the hotbed is closed up for the night. Watering in the afternoon or evening may promote the growth of a fungus which causes "damping off." This condition attacks the seedlings at the surface of the ground, causing them to wilt and decay. The disease is also likely to occur where there is lack of ventilation or where the temperature is too high.

(b) Ventilate the hotbed by adjusting the sash to maintain the temperature between 70 and 80 degrees F. If cold winds are blowing, close the top entirely to prevent the plants from becoming chilled. Low temperatures inhibit growth. On extremely cold nights, cover, or partly cover, the hotbed with old carpets, bagging, or heavy paper to keep in the heat from the fermenting manure. Remove this extra protection in the morning to admit sunlight. When the weather gets warmer, partly open the top for ventilation. This helps to produce strong, healthy plants. On hot days remove the sash entirely or the plants may wilt from too much heat, or lack of ventilation.

(c) After the seedlings appear, mulch the space between the rows every week with a small rake to lessen evaporation and check weed growth. Begin thinning and transplanting as soon as the second pair of leaves is well developed. This produces sturdier plants. A common practice is to transplant from the hotbed into flats of convenient size which may be set into the cold frame. This gives the plants protection while permitting further growth, and at the same time helps to harden them. Later the flats will be convenient to take to the garden when transplanting.

When the season's use of the hotbed is over, carefully store the sashes and the frame. Put both the soil and the manure into the compost heap which may be used later for fertilizing crops or for potting plants in the autumn; or the hotbed can be used for growing a few hills of early melons or cucumbers.

THE COLD FRAME

Enterprise 3: Preparing and using the cold frame.

The cold frame, like the hotbed, may be used to start seeds but it should not be used for this purpose until April. Its common use, however, is to serve as a place into which to transplant seedlings from the hotbed or indoor flats in order to give them more room and to harden them before transplanting into the open garden. It may also be used for storing perennials over winter.

Location and Construction: Calculate the size of frame which will meet your needs. Locate the cold frame in a place similar to that of the hotbed and also use a similar wooden frame. A pit and a manure bottom, however, are not required. Set the frame on level ground and in it prepare a bed of fine rich garden soil six inches deep. Cover it with sashes of glass or, if the season is quite late, canvas covers may be used.

If you choose, you may transplant into flats and set these in the cold frame for further care. Using the frame in this way no special bed of soil is needed in the bottom.

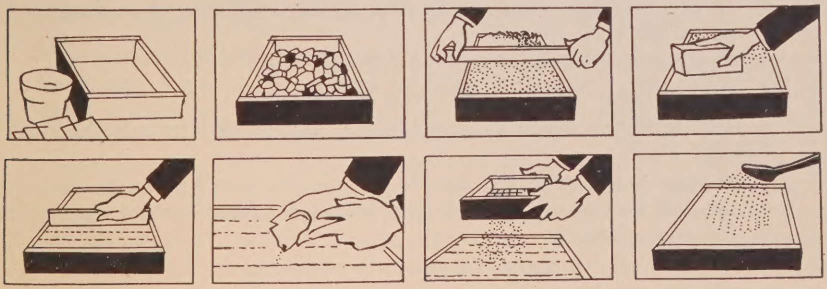
Transplanting: An hour before lifting the plants from the hotbed to transplant into the cold frame or flats, water them well. Set the plants in the cold frame or flats, in rows and about two inches apart each way. For this purpose make holes with your forefinger or a dibble large enough to receive the root without bending it. Gently pack the soil around the roots. Then water the bed or flats well and cover with the sash. What is the purpose of the cover?

Care: Water the plants thoroughly two or three times a week according to their needs. Regulate the ventilation according to weather conditions to keep the plants healthy and growing well. During warm weather remove the sash entirely.

INDOOR FLATS

Enterprise 4: Starting plants in indoor flats or shallow boxes.

Instead of using a hotbed, you may start long-season plants during March in indoor flats. This is a convenient method where only a few plants are required.



(*Courtesy, London Life*)

Fig. 47. Preparing an indoor flat.

Preparing the Flats: Make the flats about 15 by 10 inches and four inches deep. Use half-inch cedar, or chestnut lumber and make five quarter-inch holes in the bottom for drainage. Fill the flats nearly full of rich sandy loam which has been sifted through a wire screen. Press the soil down gently, wet it well, and the next day plant the seed.

Planting: In seeding the flats make narrow grooves an inch and a half apart and four times as deep as the thickness of the seed. In these grooves sow the seeds fairly thickly; cover them with fine soil and press it down. Set the seeded flats on the sill of a southern window in a warm room where they can be given careful attention. Make sure that all rows are properly labelled.

Caring for the Flats: Water the flats every other day by covering the surface with cheesecloth or thin cotton and then sprinkling with sufficient lukewarm water to keep the soil moist. This method of watering keeps the surface soil from hardening and the seeds from being washed out and chilled. Turn the flats every second day so that the plants will not be bent towards the light. Do not allow the soil to dry out. As soon as the weather is warm enough outdoors, move the flats outside during the day to harden the plants; or better still, set them in a cold frame where they can be covered during cold nights.

Thinning: When the second pair of leaves is beginning to develop and the plants begin to crowd one another, thin the rows by transplanting into other flats prepared with good soil. Light, warmth, moisture and plenty of space are required to produce sturdy plants.

It is usually more difficult to produce strong plants by the use of indoor flats than by using the hotbed, for the dry indoor air causes the plants to grow spindly.

It is a good plan to start the plants in indoor flats approximately 15 by 10 by 4 inches. Then after the first pair of true leaves has appeared transplant to a hotbed previously prepared. Set tomatoes, cabbage, cauliflower, Brussels sprouts and lettuce three inches apart, and sweet or hot peppers two inches apart. It is good practice to set the rows of tomatoes and peppers between the rows of cabbage, Brussels sprouts, cauliflower and lettuce, because the latter plants can be transplanted to the garden earlier than the tomatoes and peppers. This gives these less hardy plants more room at a time when they need it.

Questions and Exercises:

1. In gardening explain why the soil needs to be well prepared.
2. Why should the soil over planted seeds be well firmed?
3. In planting very small seeds why should a little sand or sandy loam be mixed with them?
4. Explain the sources of heat in a hotbed.
5. What causes "damping off" in a hotbed?
6. Distinguish between the construction and purpose of a hotbed and a cold frame.
7. If there is a market gardener in the vicinity visit him in the spring to see how he uses his hotbed, cold frame, or greenhouse to start plants for transplanting.
8. Explain why thinning is commonly necessary.
9. Why can sturdier plants usually be produced by the use of the hotbed than by indoor flats?

BULBS FOR FLOWERS

You may wonder why bulbs under proper conditions produce flowers so soon after planting. An observation of the cross-section of a bulb will enable you to see that it contains a bud or two, in a resting stage much like the embryo (undeveloped plant) in a corn or bean seed. Surrounding the bud, nature has stored available plant food in the bases of the old leaves. Consequently, when the bulb is planted, given favourable conditions and properly cared for, the bud grows rapidly and produces beautiful bloom.

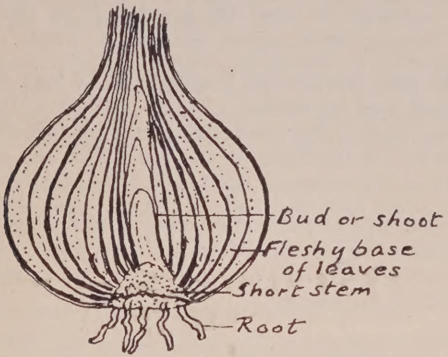


Fig. 48. Vertical Section through an onion bulb.

Enterprise 5: Planting bulbs and caring for them to produce indoor winter bloom.

(a) Growing bulbs in flower pots with soil. In October select narcissus, daffodil, hyacinth or tulip bulbs that are large, firm and free from disease. Prepare several 5- or 6-inch pots for planting, by covering the drainage holes with pieces of broken pots or pebbles; then fill the pots about three-quarters full of well-rotted manure, mixed with sandy loam which has been sifted through a wire screen. Press this down and on it set the bulbs; place one in the centre of each pot, in the case of hyacinths, daffodils and tulips; for narcissi, put them about three inches apart, three or four to a pot. Have the tips of all the bulbs level with the top of the pot, but do not force the bulbs down into the soil. Gently pack more good sandy loam around them to fill the pots within half an inch of the top, leaving the tips of the bulbs uncovered. Then set the pots in shallow water for a day to permit the soil to take up through the drainage holes all the water it will. By what action does the water rise?

Now put the pots in a cool dark place for 6–8 weeks and water them every two weeks with tepid water, preferably from the bottom. The purpose of this treatment is to cause the development of a heavy root system and retard the growth of the bud. After this period, place the pots in subdued sunlight in a warm room for 2–3 weeks; then expose them to full light in a north or east window. Continue watering sufficiently to keep the soil moist. Too much sunlight at first will cause the flower buds to expand before there is sufficient stem and leaf growth. When in bloom, if you want the flowers to last and retain their colour, do not permit them to stand in the sun or in a very warm place.

Another way to pot bulbs is to use common chicken-grit charcoal instead of soil. The charcoal offers little obstruction to the growing root and requires less watering than soil; and the enclosed ash content of the charcoal provides some plant food for the growing flower. Most of the nourishment is derived from the food materials stored in the bulb.

(b) Forcing Narcissi and Hyacinths in Bowls: A common practice is to plant clusters of a half-dozen bulbs of narcissus in a bowl about 6 inches in diameter and 5 inches deep. The material used is pebbles, gravel or chicken-grit charcoal. The bases of the bulbs are set 2–3 inches above the bottom of the bowl and enough of the material is packed around the bulbs to hold them in place and to leave the upper quarter projecting above the pebbles, gravel or charcoal. Sufficient water is supplied to keep the lower half of the bulbs submerged. Change the water once a week unless charcoal is used.

Hyacinth bulbs may be planted singly in small jars wide enough at the top to admit the bulb and to permit it to be planted in charcoal or pebbles. Add enough water to reach to the base of the bulb, but after the roots are showing keep the water below the base of the bulb with the roots reaching well into it. This allows air to surround the bulb. Otherwise it may decay.

In all cases it is better to place the bowls or jars in a cool, dark place for a few weeks to simulate winter conditions and encourage sturdy root development. Then they are ready to be brought into a warm room with moderate lighting, but not direct sunshine.

Enterprise 6: Planting bulbs out of doors and caring for them to produce bloom in the spring.

In October select large, firm bulbs of the desired kind. The best soil is a sandy loam, that gives ready drainage. When preparing a bed dig out the soil to a depth of about 12 inches, keeping the soil and subsoil in separate piles. Mix some bone meal and well-rotted manure with the soil. Then put the good soil in the bottom and level it up to the depth suitable for planting the kind of bulb selected. On this set the bulbs in rows properly spaced. If the soil is a clay loam, put in about an inch of sand before setting the bulbs, to give better drainage and to prevent decay.

In beds, plant hyacinth bulbs 7 inches deep and 6 inches apart in the rows; tulips 6 inches deep and 6 inches apart; daffodils 6 inches deep and 6 inches apart; narcissus bulbs 5 inches deep and 5 inches apart; crocus bulbs 4 inches deep and 2 inches apart. These bulbs make their root growth before the ground freezes up. If planting is too shallow, alternate freezing and thawing of the ground may cause heaving, with subsequent damage to the roots of the bulbs.

Having carefully placed the bulbs, cover them with the rest of the soil and subsoil and level up the bed. When the ground is frozen put a mulch of 3–4 inches of manure or straw over the bed for the winter to prevent rapid freezing and thawing. In the spring when the tops begin to appear remove the mulch.

Should you wish to plant clumps of about ten bulbs together in a perennial border, follow approximately the same directions but plant the bulbs a little closer and not in rows. They bloom earlier than the other plants and make the border attractive.

To make sure that the capacity of the bulbs to bloom again the following spring has been restored, the tops should be left until the leaves have turned brown. The leaves may then be cut off, leaving the bulbs undisturbed, or the bulbs may be dug up and kept in a dry place for replanting in the fall.

Enterprise 7: Investigate the structure of a bulb to find its parts and why it soon produces bloom after proper planting and care. Onion bulbs serve well for this study. The more expensive bulbs have the same structure.

With a sharp knife make a *vertical section* down through the middle of the bulb. Observe the greenish-yellow shoot in the centre and the fleshy layers of leaf-bases surrounding it. Note the small hard stem out of which these parts grew. What shape are the flesh leaves?

Now make a *cross-section* through the middle of another bulb. Observe the parts. What shape are the fleshy leaves surrounding the bud or shoot? Where do bulb plants store the food made by the leaves to serve the next generation of bloom? Explain why bulbs do better in good soil or charcoal than in stones or gravel.

Make vertical and cross-section drawings of your bulb and label the parts.

Questions and Exercises:

1. Explain why bulbs produce early spring blooms.
2. Why should a bed of bulbs be covered with a mulch for the winter?
3. Describe how to care for bulbs planted to obtain indoor bloom in winter.
4. Enumerate causes of poor bloom from indoor culture of bulbs.
5. Why should bulbs for the next season's planting not be lifted until the leaves are brown?

MAKING A PERENNIAL BORDER

A border of hardy herbaceous perennials which will give a display of colour throughout the growing season is always a delight. It is the cheapest and easiest border to manage. Old dependable varieties can be selected and arranged so that at each season there may be a riot of colour. Such an enterprise will greatly improve the landscape.

Enterprise 8: To make a pleasing herbaceous perennial border at school or at home.

Location: Locate the border along a walk, a driveway, or a fence where there is little shade.

Soil: Spade the soil to a depth of 15–18 inches and mix with it a good supply of rotted manure. Rotted sod or leaf mould instead of the manure will also put the soil in good condition. It is best to make this preparation in the fall and do some of the planting then and the rest in the spring according to the needs of the plants. Lime is specially useful on clay soils for it has a double action; it releases some of the plant food that is in the soil, making it into soluble form that plant roots can absorb and causes the minute particles of the clay to collect together in groups, so that the soil is less sticky, crumbles easily when disturbed and is easily worked.

Planting: Select strong plants that will bear abundant foliage and flowers throughout the growing season and that may be depended upon to carry over from year to year. In planting do not leave too much space between the plants or nature will fill the open spaces with weeds. Do not set the plants in straight rows, but plant the tall growing ones at the back, those of intermediate height along the centre and the low forms along the front. The following are reliable varieties which will produce overlapping bloom from April through to November; the season of bloom for most of them is from three to six weeks each.

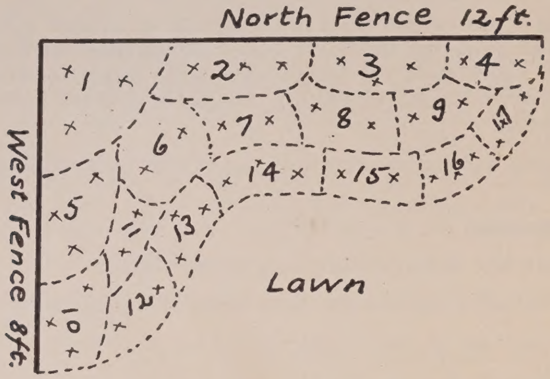


Fig. 49. A perennial border.

Planting Key:

1.	Double Hollyhocks	3 plants
2.	Delphiniums	3 plants
3.	Campanula persicifolia	3 plants
4.	Phlox paniculata	2 plants
5.	Blazing Star	3 plants
6.	Gaillardia grandiflora	2 plants
7.	Russel Lupin	2 plants
8.	Tritoma	2 plants
9.	Rudbeckia purpuria	2 plants
10.	Coreopsis	3 plants
11.	Bleeding Hearts	2 plants
12.	English Lavender	3 plants
13.	Sweet William	3 plants
14.	Phlox sublata	3 plants
15.	Daisy, Shasta	2 plants
16.	Lychnis	3 plants
17.	Alyssum, Saxatile compactum	3 plants

NAME	HEIGHT	PROPAGATION	BLOOM
Larkspur *Delphinium hybrids*	4–5 ft.	Plant divisions in spring	Blue—June–July
Bellflower *Campanula persicifolia*	2– 3ft.	Seed, or divisions in spring	Violet—June–July
Blazing Star *Liatris pycnostachya*	3–5 ft.	Seed, or divisions	Purple—Aug.–Sept.
Dropmore *Anchusa italica*	3–5 ft.	Seed in spring	Blue—June–July
Blanket Flower *Gaillardia grandiflora*	2–3 ft.	Seed, divisions or cuttings	Yellow and brown—June–Nov.

NAME	HEIGHT	PROPAGATION	BLOOM
Lupins *Lupinus*	2–4 ft.	Divisions in spring	Various colours— June–July
Perennial Phlox *Phlox paniculata*	2–3 ft.	Seed or divisions in fall	July–October
Red Hot Poker *Tritoma pfitzer*	3–4 ft.	Divisions in spring	Orange-scarlet— Aug.–Oct.
Persian Daisy *Pyrethrum roseum*	2–3 ft.	Divisions	White-crimson— Aug.–Sept.
Coneflower *Rudbeckia purpurea*	2–3 ft.	Seed, or divisions	Purple— July–Oct.
Coreopsis or Calliopsis *Coreopsis grandiflora*	2 ft.	Seed, or divisions	Yellow— June–Sept.
Sweet Rocket *Hesperis matrenalis*	1–3 ft.	Divisions, or cuttings	Purple— June–July
Bleeding Heart *Dicentra spectabilis*	1–2 ft.	Divisions of crown or roots	Rose— May–July
Sweet William *Dianthus barbatus*	10–18 in.	Seed in spring	Pink, white, red— June–July
Perennial Cornflower *Centaurea montana*	12–18 in.	Divisions in spring	Yellow— May–June
Maltese Cross or Jerusalem Cross *Lychnis viscaria splendens*	12 in.	Divisions in spring	Red— Apr.–May
Alyssum *Saxatile compactum*	6 in.	Seed in spring	Yellow— Apr.–June
Thrift or Sea Pink *Ameria formosa*	8 in.	Divisions in spring	Rosy-pink— May–July
Rock Cress *Arabis alpina*	6 in.	Seed in spring	White— Apr.–May
Hardy Pinks *Dianthus heddewiggi*	4 in.	Seed in spring	Various— June–July

You can select plants from the above list and so arrange them in the border as to give unity and harmony. Aim to give character to the border by planning for simplicity, dignity, boldness and appropriateness. Good annual catalogues from seed houses will help you.

Care: After the border is established keep it free of weeds year after year. Replace any plants which are killed out, and divide clumps which have spread too much. Do the usual cleaning up every autumn. After freezing sets in, give the border a mulch of rotted manure for winter protection and as a fertilizer.

Enterprise 9: Making bouquets of flowers.

Teacher's Purpose: To develop useful knowledge regarding the principles and practice of making bouquets.

To interest pupils in the recognition and beauty of flowers.

To cultivate skill and appreciation in flower arrangement.

I. Approach: Teacher: Why do we grow flowers?
Pupil: To make the garden or border look attractive.
To make bouquets for the house, classroom or church.

II. Enterprise: Today we are going to learn how to make pretty bouquets suitable for the classroom and for a hall table at home.

Method: Have on hand suitable flowers and vases for demonstration and practice; also two bouquets, one good and the other poor in arrangement.

Let the pupils name the flowers. Supply the names of any they do not recognize, and write them on the board.

Set the prepared bouquets before the class and ask pupils one by one to tell which is the better bouquet and to give reasons for their choice. Direct the pupils to compare the model bouquets with respect to:

1. Number and variety of flowers used.
2. Colour harmony and suitability of vase.
3. Proportion and balance, height in relation to vase.
4. Three levels of flowers in arrangement. (Largest and darkest flowers in lowest level and smallest and lightest at highest level.)
5. Arrangement of stems.
6. Charm and distinction.

Display a few pictures of well-arranged bouquets for observation to enlarge the pupils' ideas and appreciation. Summarize the points of the good bouquet on the board.

1. Use only two or three kinds of flowers and select a suitable vase.
2. Select flowers that look well together, having regard to colour harmony.
3. Avoid spotted appearance; do not mix the flowers too much.
4. Cut the stems to the desired length. If they are cut on a slant with a sharp knife the flowers will last longer.
5. Make bouquet one and one-half times as tall as the vase.
6. Arrange in graceful curves and in three levels. Avoid crossed stems.
7. Arrange biggest and darkest flowers in the lowest level, smallest and lightest at highest level over the centre of the vase.
8. To give them distinction, avoid crowding the flowers.

Application:

1. Arrange pupils in groups of twos, and direct each group to make a bouquet, using the flowers and vases at hand. Supervise the activity giving suggestions where necessary. Then judge the work done, giving reasons.
2. For the next two or three weeks, have groups of two pupils volunteer to keep the classroom provided with a bouquet of well-arranged flowers.
3. Direct pupils to write a composition on "How to Make a Bouquet."

GROWING FRUIT TREES AND BUSH FRUITS

First consider the kinds of fruit trees and bush fruits grown in the neighbourhood. In this way you will learn the kinds that thrive in your local soil and climate.

FRUIT TREES

Enterprise 10: Planting and care of fruit trees.

Preparation: Prepare the soil in much the same way you would for a garden. Fruit trees grow best in a soil that has plenty of well-rotted manure worked into it to hold the moisture and to stimulate growth.

Selection: Leading varieties of apple trees for summer fruit are Yellow Transparent and Astrachan; for the fall—Duchess, Maiden's Blush, Alexander and Gravenstein; for early winter—Wealthy, St. Lawrence, Melba, McIntosh, King and Greening; for late winter—Northern Spy, Baldwin, Delicious, Tolman Sweet and Golden Russet. There are fewer varieties of cherry, pear, peach and plum trees from which to select.

Planting: Where quite a number of trees are to be planted, first study the layout of a good orchard. The square is the usual planting arrangement. In the case of apple trees they are planted 30 or 40 feet apart each way, four trees making a square. The rows run straight across the site and also lengthwise of the site. This gives the planting an attractive appearance and permits easy cultivation in both directions between the rows. If desired, garden crops or small fruits, such as strawberries, may be grown between the rows during the first few years.

A common practice is to interplant varieties which begin to bear at an early age as "fillers" midway between the rows of the permanent trees, which do not begin to bear till somewhat older. Then later, when the permanent trees need the room, the "filler" rows are removed. Sometimes peach, pear or plum trees are planted between the apple tree rows as inter-cropping.

The trees may be planted either in the fall after they have shed their leaves or in the spring before the buds have opened. The usual practice is spring planting. In the fall, however, the soil may be easier to work, and fall planting permits the soil to settle well around the roots. This is favourable for stimulating earlier spring growth. On poorly drained soil, however, there may be too much moisture around the roots, causing alternate freezing and thawing to injure the roots by heaving. Moreover, should the winter be windy and dry, the stems and branches may suffer from excessive drying out.

Trees should be planted as soon as possible after they are received to prevent the roots drying out from exposure to the sun and wind. If permanent planting must be delayed, set the roots and stems in a temporary trench and cover them over with moist soil, heeling them in. In planting make the holes wide enough and deep enough to avoid bending and twisting the roots, and to permit the trees to be set a little deeper than they grew in the nursery. Place the soil and subsoil in two separate piles. Then put into the bottom of the hole some of the best soil and spread out the roots. If any roots are broken or damaged, trim them off with a sharp knife just above the injury. Place the trees so that the heaviest branching is to the north and with the whole tree slanting slightly westward. Why? Then fill in around the roots with the remaining soil and pack it to leave no air pockets. Now add enough water to soak the soil. Finish by filling in the subsoil on top to level up. A little pruning of the branches may be necessary to balance any loss of roots in the transplanting.

The method of planting peach, pear, plum and cherry trees is the same as that for apple trees, but the rows are usually placed only 20 to 30 feet apart since they develop smaller heads than apple trees.

Care: Trees should have a mulch of manure or straw around them the first year. After the second year, if necessary, prune the heads in the late winter or early spring. This operation requires the removal of all dead or diseased parts, all broken limbs or twigs, and all branches growing across others, as well as cutting back by a third or a half any new growth which is developing too fast. The chief object of pruning is to keep the head of the tree well balanced and to allow plenty of light and air to enter all parts. In removing limbs, cut them close to the main branch or stem so as not to leave stubs. In this way the wounds may heal over. Cover the cut surfaces with grafting wax or with a mixture of dry Bordeaux and raw linseed oil rather than with paint. After they begin to bear, peach, cherry, and plum trees need more pruning than apple and pear trees.

Spraying is essential in the spring to control insect pests and fungus diseases. The trees will not be fully productive without spraying. To know what to use, and when and how to spray, consult an up-to-date spray calendar. The materials commonly used for fungus diseases are lime-sulphur and Bordeaux mixture, and for insect pests arsenate of lead and nicotine sulphate.

BUSH FRUITS

Enterprise 11: Planting and care of bush fruits.

(*a*) *Raspberries* and *Blackberries*

Planting: Raspberry and blackberry bushes do best on rich black soil or on a rich loamy soil in an open exposure. They are commonly grown from suckers and should be planted in rows five feet apart with the bushes set three feet apart in the rows. The time and methods of planting are similar to those of fruit trees. Cultivation between the rows is needed year after year.

Care: Pruning is important for the development of good fruit. The canes are biennial and bear fruit the second year. Therefore the old canes should be removed at the end of their second year to give the new ones room. Long one-year-old canes need cutting back to cause them to branch for fruit clusters. Any canes affected by crown gall or by cane blight should be cut out and burned. By proper cultivation, protection and pruning both raspberry and blackberry patches will remain productive for years.

Some winter protection is needed to keep the bushes thrifty. To do this make a trench or furrow along one side of the row, then bend the canes down into it and cover them with two or three inches of soil. In the spring, after danger from frost is past, uncover them and bring them back to their original position.

(*b*) *Currants and Gooseberries*

Planting: Currant and gooseberry bushes prefer a heavy well-drained soil that has been well fertilized with manure. Plant the bushes in rows about five feet apart each way and press the soil well down around the roots. Leave a light mulch on top to prevent the escape of capillary moisture. During the first year a garden crop may be grown between the rows to avoid wasting space and to keep it free of weeds. Regular cultivation improves the quality and quantity of fruit.

Care: Since red currants produce their fruit on spurs on wood two, three and four years old, the young bushes need little pruning except what is needed to give them proper shape. Older bushes should have most of the five-year-old wood removed every spring. Black currant bushes, however, bear their fruit chiefly on wood of the previous season's growth. Therefore prune to cut away the older wood and to keep the bushes well shaped and not too thick. Any wood attacked by borers should be cut out and burned. Usually it is necessary to spray the bushes before the blossoms open with arsenate of lead or Paris green to control the currant worm attacking the leaves. If a second brood appears dust the bushes with hellebore when the foliage is wet. Should leaf-spot appear, spray with copper carbonate before the fruit is picked and with Bordeaux mixture after the fruit has been picked.

Questions and Exercises:

1. Give reasons why fruit trees and fruit bushes are commonly planted in the spring.
2. In planting trees explain (a) why the side with the most branching. should face north, (b) why the tree should lean slightly westward, and (c) why the soil should be packed around the roots.
3. Why should bush fruits not be over-crowded in the rows?
4. Describe how to prune (a) trees, (b) fruit bushes.
5. What are the following sprays used for: Bordeaux mixture, arsenate of lead, hellebore, lime-sulphur?

GROWING STRAWBERRIES

Strawberries are commonly planted in what is known as the matted row.

Enterprise 12: Planting strawberries. Care of the strawberry patch.

Preparation: Select an area with a sunny exposure and having a sandy loam soil. Fertilize the soil with rotted manure and bone meal, before cultivating it thoroughly. Secure one-year-old plants from a mature patch of the desired variety. Select a variety that bears *perfect* flowers (that is, flowers containing both stamens and pistils), such as Premier, Senator Dunlap, or Parson's Beauty

Planting: In late summer or early spring set the young plants in rows three or four feet apart, and one to two feet apart in the row. Make the holes big enough to spread the roots well. Then place the plant with the crown just at the surface, cover the roots well and press the soil down on them. Do not cover the crown. Do not water the plants, for this will cause the roots to grow upward.

Care: As soon as planting is completed, cultivate between the rows and immediately put on a mulch of clean straw. This conserves the moisture all summer. If more straw is added to it in the spring, the pickers will have clean paths and the berries will be free from dirt or sand. Mulching is also useful because it keeps down weeds during the summer, and because it prevents the alternate freezing and thawing which in fall or spring have a tendency to heave the plants out of the ground. Watch for mildew, leaf-spot and rust; control these by spraying with Bordeaux mixture. Plant new rows, on newly prepared land, every two years.

Questions and Exercises:

1. Why do strawberries need plenty of sunlight, fertile soil and careful mulching with straw?
2. How do strawberry plants propagate themselves?
3. Discuss the advantage of growing strawberries by the hedge-row system rather than by any other you have observed.
4. How may mildew, leaf-spot and rust be controlled?

GROWING RHUBARB

Why is rhubarb sometimes called the pie-plant? Find out which of the following varieties are grown in your neighbourhood: Strawberry, Victoria, Ruby, MacDonald's, Sutton's.

New patches of rhubarb are usually started by planting the divisions of roots taken from the selected variety. Starting from seed requires longer to produce a crop.

Enterprise 13: Planting and care of rhubarb in the garden.

Planting: Since the planting is productive for years, locate the patch in a corner or along the side of the garden. Deeply cultivate the soil and incorporate plenty of manure. In the early spring or late fall take pieces of roots from an old bed, or dig up old roots and divide them into sets so that each has at least one strong root, crown and bud. Make holes four to five inches deep and three to four feet apart each way, depending upon the available space. Plant the pieces just deep enough to keep the eyes or buds level with the top of the soil. Pack the soil firmly around the roots.

Care: During the summer keep the soil mulched to control weeds and to retain moisture. Remove no leaf stems the first year and very few the second. This permits the development of strong crowns for future crops. Remove seed stocks as soon as they appear. Cover the crowns with manure each fall. Small, puny growth indicates starvation.

Enterprise 14: Winter forcing of rhubarb. This is a simple process that will provide a liberal supply of tender mild fresh rhubarb during January, February and March. Two vigorous roots will provide sufficient fresh rhubarb for a household of six persons.

Dig up the hills late in the fall and place them on leaves or straw until slightly frozen; then either pack them in a corner of the cellar in sand, or in boxes stuffed with straw, leaving the crowns nearly exposed. In the middle of November force one box or hill by watering occasionally with tepid water. In two or three weeks the buds will begin to develop; then start the second box. The rhubarb may take six or eight weeks to grow to a height of a foot or more. No sunlight is necessary to produce this crop. The old roots are rarely worth saving after forcing.

References:

Ontario Department of Agriculture, Toronto:
    Publication 432—*The Home Vegetable Garden*
    Publication 403—*Important Fruit Tree Diseases*
Dominion Department of Agriculture, Ottawa
    Publication 684—*The Vegetable Garden*

HARVESTING AND STORING VEGETABLES

It is important for producers, retailers and consumers to know how to harvest and store vegetables properly. Heavy losses are often incurred because of ignorance or carelessness. Whether the vegetables are to be stored for family use during the winter or are to be held for better prices when the market is not glutted, the same care should be taken.

HARVESTING

For storage purposes all harvesting should be done during fine weather, so the vegetables may be dry and clean. Only the well-grown and fully matured vegetables which are free from mechanical injury and from damage caused by insects, disease or freezing should be selected for storage.

STORAGE

The storage methods used are designed to prevent as far as possible loss by decay, shrinkage and general deterioration.

(a) *Potatoes:* Dig potatoes without injuring them and leave the tubers on the ground for a few hours to permit the surface moisture to evaporate. In gathering the crop for storage, reject all small, diseased or damaged tubers. Put the potatoes for storage into crates, boxes or barrels rather than in large bins where there is no circulation of air. Maintain the storage temperature from 36–40 degrees F. and exclude strong light and dampness. Should sprouts develop during the spring remove them and also any tubers which show signs of decaying. A good cellar or a dry pit with sufficient covering will usually save potatoes during cold weather. If the storage is warm and dry the potatoes sprout and shrink, and if too cold they freeze and become sweet to the taste.

(b) *Carrots:* Pull or dig carrots late in the fall and snap off the tops from the crown to prevent excessive bleeding and drying. Like potatoes, gather the carrots after the surface moisture has evaporated. They may be piled in heaps and covered with sufficient soil to prevent freezing; or they may be stored in a cool, ventilated cellar and covered with sand. A cold frame with sufficient covering to prevent freezing is also a good storage place.

(c) *Cabbage:* To harvest cabbage pull them up by the roots and remove the outer leaves from the heads. Store them in a cool cellar with roots up and heads standing on moist, sandy soil, but not touching one another. Pack sand or straw well around the heads. Another way is to make a trench on a dry slope and set the cabbage, heads downwards in it. Then pack sand or straw around them and cover with loose soil. Ventilation is necessary between the heads.

(d) *Beets:* Pull the beets and twist off the tops from the crown. In this way bleeding and loss of colour are avoided. Permit surface drying and then store the roots in a cool cellar and cover them with sand; or store them outside in a pit with sufficient soil over them to prevent freezing.

(e) *Onions:* Pull onions after the tops are dead and leave them in the sun to dry the roots thoroughly. Then tie them together by the tops and hang up in a dry, cool place. If you have many to store, cut off the tops and spread the bulbs over a dry floor to a depth of three or four inches, or put them into slatted boxes or coarse mesh bags in a cool, dry place. They need plenty of ventilation, and a freezing does not injure them, except in the case of Spanish onions.

(f) *Celery:* Pull up celery and trim off only a few of the longest roots. To store for the winter prepare boxes about a foot deep with holes in the sides. In the bottom put two inches of wet sand. When the celery leaves are free of surface moisture pack the bunches upright and close together with roots resting on the wet sand. Maintain a low temperature and keep the sand moist by pouring water through the holes in the sides of the boxes. Do not allow water to touch the leaves.

(g) *Pumpkins* and *Squash:* Harvest these vine crops as soon as the stems become dry and shrunken. First go over the patch and turn the light side of each pumpkin or squash to the sun for about three days. Then carefully remove them from the vines, leaving about two inches of the stem on each. Store only unbruised specimens in a dark, dry cellar or attic where the ventilation is good and the temperature does not go below 50 degrees or over 65 degrees F. A well-ventilated furnace room, or a place where there is a warm stove-pipe or chimney, may serve the purpose. Squash will keep longer than pumpkins.

(h) *Tomatoes:* To store tomatoes to keep till December pick them when mature, but green, free from cracks, skin punctures, or freezing injury. Wrap each tomato in paper and place the lot in a closed box or drawer where the temperature is maintained at about 50 degrees F. Under this storage condition they will ripen for Christmas.

Questions and Exercises:

1. Plan an experiment to show why nature provides perishable vegetables with a skin.
2. Explain why vegetables for storage need to be carefully handled.
3. List vegetables that require: (i) a cool temperature for storage, (ii) a warm temperature for storage.
4. Grow vegetables in your school garden and store them to serve as hot lunches during the winter.
5. Why are vegetables bought on the market often unsuitable for home storage?
6. Which vegetables are frequently canned to preserve them?
7. Make a list of ten garden vegetables and tell which part or parts of the plant are used for food.

References:

Dominion Department of Agriculture, Ottawa
Publication 743—*Home Storage for Fruits and Vegetables*

CONTROL OF INSECTS AND WEEDS BY CONSERVATION OF BIRDS

In dealing with birds in relation to agriculture, the primary concern of the teacher is to lead pupils to see how birds help man and how he can help the birds. The instruction should emphasize the enormous benefits the farmer or gardener derives from bird life in his struggle against insect pests, destructive rodents and weed seeds. Most birds need to refill their stomachs from eight to twenty-five times a day.

Before man practised agriculture, the problem of holding insect and weed pests in check did not concern him; the principle of "balance in nature" did this for him. As insect life increased, bird life also increased and thus maintained a state of balance. But as soon as man cleared large areas of land for the purpose of raising field and garden crops, insects left their native feeding grounds in the forests and grass lands to find in the cultivated fields, orchards and gardens more abundant food no less suited to their taste. Consequently insect life multiplied at an enormous rate. At the same time many birds, because they were afraid of man, moved back from the cleared areas into secluded haunts where they were of no direct benefit in controlling insects and weeds on farm lands. Thus an unbalanced condition developed which gradually revealed to man that he needed the assistance of the birds in his war against insect and weed pests and that, therefore, he must encourage, protect, and make friends of these timid creatures.

Earlier generations looked upon birds as robbers rather than friends. They observed birds in the open fields and gardens picking at buds, eating fruits and seeds, and occasionally seizing young poultry. For these reasons they often destroyed birds. In their casual observations these people saw only the little harm done by the birds and did not realize the great benefits which were rendered. Facts and figures from unbiased scientific investigations, however, have almost completely changed this hostile attitude into one of friendliness and encouragement. Investigations by students of bird life and by biologists into the feeding habits of many birds have revealed the fact that the benefits to man of nearly all birds far transcend the little harm a few of them may do.

FEEDING HABITS OF BIRDS

Professor F. H. King, in examining the stomachs of twenty-one woodpeckers, found that "eleven of them had eaten 52 wood-boring larvae; ten of them 105 ants; five of them 13 caterpillars; six of them 10 beetles; two of them 2 cockroaches; two of them 9 egg-cases of cockroaches; two of them 2 moths. One had eaten a small snail; one some green corn; one a wild cherry; and one red elderberries."

Dr. Fisher, in his investigation of the food habits of the owls, for the Department of Agriculture at Washington, made the following report on the Screech Owl: Of 254 stomachs examined, one contained the remains of a pigeon; 38 contained other birds; 91 contained mice; 11 contained other small mammals; 25 contained frogs, lizards, etc.; 107 contained insects of various kinds, and 43 were empty.

William Rittenhouse gives some interesting robin arithmetic. He says that a pair of robins eat two worms or insects a minute for 720 minutes each day, all summer long. The robin starts to look for the early worm at five o'clock in the morning and keeps up his search till five o'clock in the afternoon. That makes 12 hours and accounts for 1,440 worms or insects a day for the pair. This pair of robins also raises one or two broods of young robins and these must also be fed. Robins stay with us at least four months and live about fifteen summers, if their enemies—usually cats, boys, and men with guns—permit them to do so. In one lifetime, therefore, one pair of robins could destroy 2,592,000 bugs and worms.

Most insects and worms, when not interfered with, increase at an appalling rate. One pair of potato beetles, unchecked, could increase to 501,000 in one summer and leave 250,000 pairs in the pupa stage, to pass the winter and be ready for action the following July. At the same rate of increase during the second year, these would aggregate 12,500,000,000,000. The bird that destroys the early bug is a friend in need and a friend indeed to the farmer. The rose-breasted grosbeak is particularly fond of potato beetles and tussock moths.

Just as the potato beetles increase rapidly and destroy the potato crop, so countless other insects are threatening to destroy our crops of the field, orchard and garden. Some of these, such as the white grubs and cutworms that live in the soil, cut off the roots of plants, while others, like aphids and caterpillars, feed on the upper parts of plants. Fortunately for man's welfare, there seems to be at least one bird which serves as a natural check upon the increase of nearly every kind of insect pest. The snipe, the woodcock and the robin are adapted for searching in loose soil for grubs; larks and sparrows, for scratching among grass and dead leaves for insect larvae and weed seeds. Catbirds, warblers and vireos feed on insects which they find on foliage. Nuthatches, chickadees, wrens and creepers are useful for cleaning insects and their eggs from the bark of trees. Woodpeckers are specially equipped for drilling holes in search of wood-borers. Swallows, swifts, flycatchers and nighthawks, find their food in ridding the air of insect pests. Where birds are scarce, plants that complete their life cycle without attack by insects are fortunate; but where insectivorous birds are encouraged and protected, the number of insects is very much reduced.

A second group is composed of birds, such as the snow bunting, the field, song and tree sparrows, goldfinches, meadow-larks, grosbeaks, and the bob-white or quail which are adapted to feed upon weed seeds. Everyone should be taught that these birds need much more encouragement and protection to aid us in the control of weeds.

A third group is adapted to seize and feed upon small rodents such as rats and field mice which, during certain times of the year, do much damage to grains and vegetables. It is not uncommon to find many fruit trees in young orchards destroyed by being girdled by meadow mice. These animals multiply rapidly, having from five to ten young in a litter and from five to seven litters in a year. It is estimated that in some sections of the country favourable for mice one pair in five years could increase to over 2,500,000. Hawks and owls, however, if given a chance, will largely keep these destructive rodents in check. Unfortunately, at the present time, hawks and owls are not protected by the Ontario Birds Protection Act in spite of the fact that they have the habit of seeking out areas where mice and other destructive rodents have become abundant. Only the great horned owl, Cooper's and sharp-shinned hawks, and the goshawk may be classed as nuisances because they feed to some extent upon poultry and other birds.

A fourth group is adapted to serve man as scavengers. Our gulls and crows are continually searching for dead animal matter as food and thus preventing pollution of the air. If it were not for gulls frequenting our harbours and shores to feed upon dead fish which are being continually washed up by the waves, these places would be very unpleasant at times.

BIRD PROTECTION

How to protect and encourage birds is knowledge worth inculcating in the minds of boys and girls. The art of presenting it should aim at appreciation of the importance of birds and the need of conservation of bird life.

A common means of attracting birds is to feed them in winter and furnish them with drinking and bathing places in summer. These places should be protected against stray cats which sneak around to prey upon birds. No one ought to keep either cats or dogs that have the habit of killing birds. A sensible practice is to put a bell on a pet cat to warn the birds of its approach.

Thoughtless boys who rob birds' nests should be checked and shown the error of their ways. As a counter-attraction they might be interested in building bird houses suitable for birds that are known to use them. Like many young people today, they may find pleasure in supplying nesting boxes for house wrens, bluebirds, purple martins, flickers, screech owls, wood ducks and robins. A pamphlet on the construction of bird houses may be had from the Extension Department, Ontario Agricultural College, Guelph.

A few fundamentals of constructing bird houses are:

(1) Wood is the best material for making bird boxes.

(2) Weathered lumber is better than new lumber. If it is new, paint the box brown or dark green, or put it up in the autumn so that it may become weathered during the winter.

(3) Use slabs or bark to make the box appear rustic.

(4) Make the entrance circular and just large enough for the bird to enter easily—one inch for the house wren, and one and a half inches for the bluebird.

(5) A hinged top or side is convenient for cleaning the house.

(6) Supply a small opening for ventilation at the back of the box near the top

(7) Place bird houses where they will be protected against English sparrows and starlings, squirrels and cats.

(8) All bird houses should have only one room except those for purple martins. They prefer apartment houses.

Another way to protect and encourage birds is to plant shrubbery and trees as nesting places and to supply fruit upon which they may feed. In selecting shrubs and trees, choose varieties that will supply food more or less continuously throughout the season. Common examples are the mulberry for the summer, the wild black cherry for the autumn, and Virginia creeper, wild grape vine, sumach and barberry, especially for the winter and spring months. These wild fruits will also serve as a protection for the cultivated varieties. Many birds attack the farmer's fruits because there are insufficient native fruits in the vicinity to supply their needs.

The Protection of Birds Act and The Game and Fisheries Act are two Ontario statutes which provide protection for birds. By these Acts it is unlawful to kill or take or injure most of our native wild birds. The exceptions are hawks, owls, crows, cowbirds, blackbirds (grackles) and house sparrows.

The two Acts are jointly enforced by officers appointed by the Deputy Minister of Game and Fisheries. These officers are located in various sections of the country, and are authorized to exercise the powers of a justice of the peace or the powers of a police constable. Penalties for destroying protected birds, or their eggs, are to be not less than $10.00 and not more than $100.00 and may in addition thereto include a term of imprisonment not exceeding six months. However, any resident of Ontario who desires to secure birds or birds' eggs for scientific purposes, and is vouched for by a responsible person, may be granted a permit by the Deputy Minister of Game and Fisheries, Toronto, Ontario. Such a permit is only valid for the calendar year in which it is issued. Anyone desiring a complete copy of The Ontario Birds Protection Act should apply to the Ontario Department of Agriculture for Bulletin 218. The Dominion Statute, The Migratory Birds Convention Act, may be had from the Publications Branch, Ottawa.

Assignment: As a review of matter on the Control of Insects and Weeds by the Conservation of Birds, arrange a panel discussion with two or three pupils of the class. (See p. 126.)

Section Seven . . . Plant Diseases

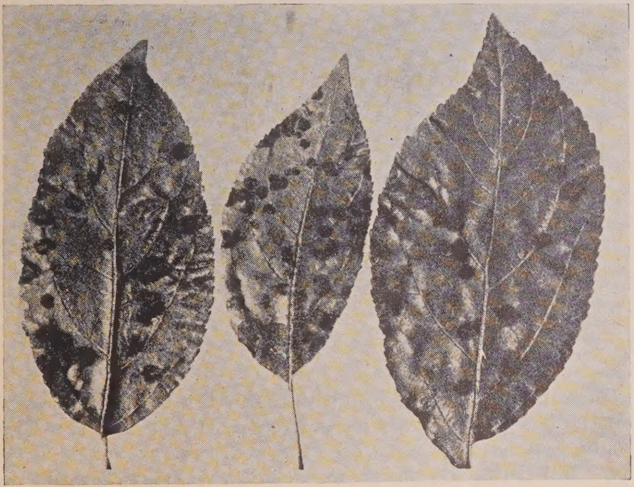
- Apple Scab
- Potato Scab
- Black Knot
- Corn Smut
- Stem Rust of Wheat
- Test

SECTION SEVEN
PLANT DISEASES

Approach: Many plant diseases are of economic importance because they greatly reduce both the quantity and quality of crop yields. The diseases are usually minute plants which cannot manufacture their own food as green plants do, so they take it from the sap of their hosts. For this reason they are said to be parasitic in habit. It is very important that they be recognized and controlled wherever possible. This is not always easy for they reproduce by means of numerous minute spores which are widely distributed by moving air and water. In 1933 Charles Lindbergh found spores of plant diseases floating in the air at an altitude of about 18,000 feet. When the spores find their way to plants which may serve as hosts they germinate and produce the plant disease.

APPLE SCAB

The common Apple Scab (*Venturia inaequalis*) is a fungus disease which is a very serious pest in the apple orchards of Ontario. You may have observed growers spraying trees to control it.



(Dept. of Agriculture, Ottawa)

Fig. 50. Apple Scab, leaf infection.

Problem 1: To learn the characteristics, life history and control of apple scab.

Method: Exhibit a number of scabby apples and some leaves which you can gather from under trees that bore scabby apples, or from apple trees that were not sprayed during the previous season.

Find the black and brown scab spots on the apples and examine them with a hand lens. Are they bordered with a greyish rim? Has the fungus disease cracked the apple and stunted and deformed its growth? Compare the quality and flavour of a scabby apple with one free from scab. Did you find that the

Do not plant root crops such as beets, mangels and turnips within the five-year interval for these may continue the infection of the soil.

(c) Do not apply lime, wood ashes, or an alkaline fertilizer to the soil for potatoes. An alkaline soil condition promotes scab development and a slightly acid condition retards it and increases the yield of the potato crop.

(d) Treat uncertified seed potatoes with *corrosive sublimate* (mercuric chloride). Purchase this chemical from a druggist either in tablet form or as a powder. Use it carefully for it is exceedingly poisonous. Add approximately 4 ounces of the corrosive sublimate to 25 gallons of rain water and do not use metal containers. Submerge the washed potatoes in the solution for one and a half hours; then remove them and spread them out to dry. They are now ready to be made into cuttings for planting.

(e) You may also treat seed potatoes with a *formalin solution* as a disinfectant for controlling scab. Mix 1 pint of formalin with 25 gallons of water and submerge the potatoes in the solution for two hours. Then spread them out to dry and make the cuttings for planting. This treatment is not as effective as that of corrosive sublimate.

Questions and Exercises:

1. After potatoes have been treated never put them back into dirty sacks or barrels. Why?
2. Explain why scabby potatoes should never be planted without being treated with formalin or corrosive sublimate.
3. Describe potato scab and tell why it reduces the value of a potato crop.

BLACK KNOT

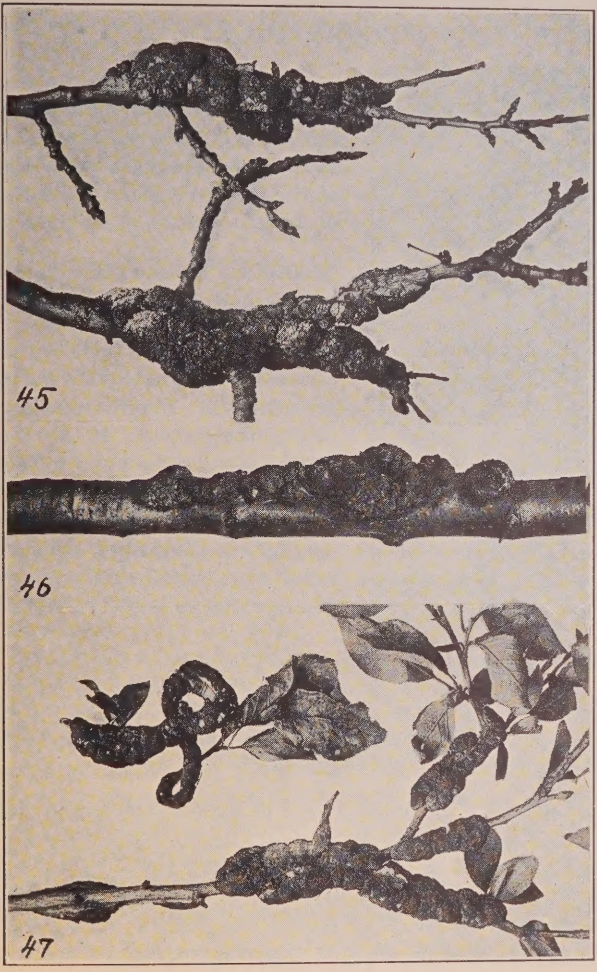
Black Knot (*Plowrightia morbosa*) is a fungus disease commonly found on the branches of plum and cherry trees. It is a parasitic growth which is easy to recognize and very destructive.

Problem 3: To learn the characteristics, life history and control of black knot.

Method: Search plum or cherry trees in the spring or fall for dark-coloured wart-like swellings on the younger branches. Bring some into the classroom for investigation. Note the shape of the swellings and the colours and roughness of the surface. Does the growth completely encircle the branch? Is it hard, dry and cracked? Examine the surface with a hand lens and describe what is seen. How does this fungus disease affect the health of the tree and the growth of the fruit? Are trees sometimes killed by it?

If you carefully examined the spindle-shaped swellings in the spring you found that the younger ones were covered with a light velvety-green coating consisting of numerous fungus threads (mycelium) and spring spores. If you made a fall examination, you found the swellings to be black and cracked and the surface studded with very small black pimple-like bodies. These are hollow and are the *fruiting bodies* (perithecia) of the fungus in which fall and winter spores are matured.

Life History: Black knot may begin with the spring spores (conidia), or with the winter spores (ascospores). Most of the infection or start of the disease is caused during May and June by the mature winter spores of old knots. These spores are spread by water and wind, and find lodgment in cracks and wounds, or on the young growth of trees. Often the mycelium threads of old knots are perennial, and the knots enlarge and produce a new crop of spores each year. In the development of knots the mycelium threads take nourishment from the sap, with consequent starvation and dwarfing of the branches on which the disease is found.



(Dept. of Agriculture, Ottawa)

Fig. 52 Black Knot

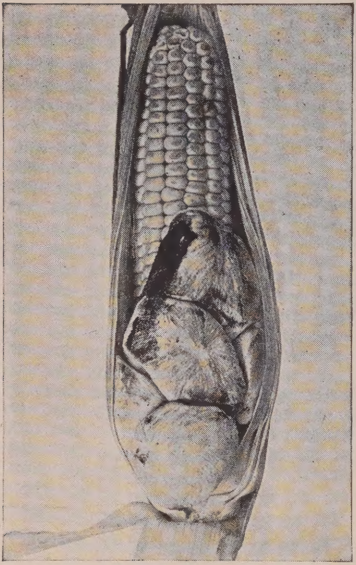
Control: The *control* of black knot is not difficult where vigilance and co-operation are exercised.

(a) Carefully inspect the trees twice a year for black knot, once in the early winter and again in the early summer. Cut out all diseased limbs about four inches below the knots and burn them to destroy the spores.

(b) Keep the plum and cherry trees sprayed during May and June with lime-sulphur, as directed in a spray calendar for these trees.

(c) Co-operate with neighbours in control measures so that spores may not be wind-borne from one orchard to another.

CORN SMUT



(Dept. of Agriculture, Ottawa)

Fig. 53. Corn Smut.

Corn Smut (*Ustilago zeae*) may be found in some corn patches attacking the tassels, stalks, leaves or ears any time after the corn is three feet high. The symptoms of the disease appear as "boils," especially on sweet corns such as Golden Bantam.

Problem 4: To learn the identification, life history and control of corn smut.

Method: Find the "boils" of corn smut on corn plants and note what parts of the plant are attacked. Describe the colour and surface of the growth. If the "boils" are not ruptured cut some open to find the nature of the interior. If you find a powder note its colour and examine some with a hand lens or a compound microscope. The powder consists mainly of spores. The disease attacks both the stem and the ear.

If you observed specimens from young corn plants, you found them to be green or white, with a polished surface; if you made the observation in the fall of the year, you likely found the boils ruptured and exposing a mass of brownish black powder composed of very many spores.

Life History: Corn smut develops from the spores which were formed within the "boils." The mature spores are scattered by wind and water to other plants, or may winter in soil, or barnyard manure, where they germinate and produce many secondary spores. During the growing season of corn these infect the tissues of the plants and give rise to the characteristic "boils" which you found.

Control: There are several ways to control corn smut.

(a) Go through the corn patch during the early growing season and cut out all smut growths and burn them.

(b) Avoid applying fresh manure directly to the corn land.

(c) Practice a three- or four-year crop rotation system so that corn will not be grown on the same land more than once in the rotation. The spores lodged in soil lose their power to germinate in three or four years.

Questions and Exercises:

1. What is found in the "boils" of corn smut?

2. Distinguish between young and old growths of corn smut.

3. What agents spread the spores?

4. State two activities which help to control the spread and development of corn smut.

STEM RUST OF WHEAT

Stem Rust of Wheat (*Puccinia graminis*), is a fungus disease which attacks the stems and leaves of wheat and other cereal crops. It is generally recognized as the most damaging enemy of wheat and can be found as red spots on the stems during the growing period, and as black spots on the straw after harvest.

Problem 5: To learn the identification, life history, and control of stem rust of wheat.

Method: (a) During the fall, winter or early spring find the black spots of rust on wheat straw and observe them with the aid of a hand lens. These contain winter spores.

(b) During the early summer search for yellowish patches of cluster-cups, filled with spores, on the underside of the leaves of the common barberry (Berberis vulgaris). (This shrub can be readily distinguished from the Japanese barberry by the facts that it has a three-pronged spine at the base of each cluster of green or purplish leaves, and that the margin of the leaf is saw-toothed.)

(c) During the summer before harvest observe that the rust spots on the stems of wheat are red. If you observed all these, you saw the three stages in the life cycle of this stem-rust fungus. Compare your observations with good pictures of the stages.

Life History: In the life cycle consider the red openings on wheat stems as the first stage. These are filled with many thin-walled red spores known as *summer spores* which are blown by the wind to neighbouring stems or to other wheat fields far away, where infection takes place when the spores germinate. In a week a new crop of red summer spores may be the result and these again are spread. Later in the season the mycelium threads of the fungus develop thick-walled black spores instead of thin-walled red spores. These black spores are known as the *winter spores* or second stage. They pass the winter in a dormant condition, but in the spring they produce *sporidia* or *spring spores* which are blown to the leaves of the common barberry. There the sporidia germinate and *cluster-cups* filled with chains of spores are produced on the underside of the leaf. This is the third principal stage in the life cycle. The cluster-cup spores escape and are carried by the wind to the growing wheat plant, and again give rise to the red summer spore stage. The chief physical agents needed to promote the development of rust are moisture, moderate heat, and wind.

Control: The control of stem rust is a difficult matter as you can see from the nature of its life history and the distribution of spores by the wind. The control practices are:

(a) Destroy the common barberry bushes in wheat-growing areas.

(b) Grow early-maturing wheat, because infection usually increases more rapidly as the season advances. A crop maturing even one week late may yield poorly filled kernels of wheat, because of rust infection.

(c) Dusting the growing crop with sulphur once or twice a week has proved effective, but the process is difficult.

(d) Sowing rust-resistant wheat, such as Apex or Thatcher, is practiced in Western Canada.

Questions and Exercises:

1. Name the three stages in the life cycle of the stem rust of wheat and tell where each may be found.
2. What conditions are favourable for the rapid spread of this fungus disease?

A GENERAL TEST ON PLANT DISEASES

Directions: Fill in the blanks with words which make the statements correct.

1. The three principal successive stages in the life history of stem rust of wheat are: (a).. (b).. (c)..
2. To find the cluster-cup stage in the life cycle of stem rust of wheat search the..during the..
3. The stem rust of wheat is reproduced by means of.................................... which are spread by..and....................................
4. In farming practice the stem rust of wheat may be controlled by (a).................................... (b).............................. (c)....................................
5. Black knot can be found attacking the branches of (a).................................... (b)..
6. The colour of young black knot is..and its surface is covered with..
7. Black knot is a..disease which takes its food from the..of the host.....
8. Co-operative measures for controlling black knot aim to prevent the spread of..by the..
9. As a means of controlling black knot cut off the diseased branches............ ....the knot and burn them to destroy the....................
10. The bacteria which cause potato scab may be in: (a).................................... (b).. (c)..
11. The roughness of the surface of potato scab is owing to.................................. ....which can be seen.
12. Precautions practised by potato growers to control scab are: (a)................ ....
    (b)..
    (c)..
    (d)..
13. The taste of a scabby apple is usually.. and its texture..

14. The winter stage of apple scab is found on..........................and................and produces.......,..which are blown by the wind to.-..during the growing season and give rise to the summer stage which produces.. causing further infection.

15. The fungicides commonly used as a spray to control apple scab are: (a)... (b)...

References:

Ontario Department of Agriculture, Toronto
    Bulletin 403—*Important Fruit Tree Diseases of Ontario*

Dominion Department of Agriculture, Ottawa
    Publication 666—*Stem Rust of Cereals*
    Pamphlet 134—*Powdery and Common Scab of Potato*
    Publication 519—*Apple Scab*

APPENDIX A

THE PANEL DISCUSSION METHOD

The panel discussion, which is now quite commonly used for radio broadcasts, has many advantages as a teaching device. Several places have been indicated in the foregoing pages, where a panel discussion might be successfully used, either to introduce a topic, to summarize a number of related details, or to add emphasis to an important part of the work. If properly used, and not to excess, it is certain to arouse interest. It calls for skill on the part of the teacher in choosing the topic, in assigning it to the pupils best fitted to carry it out, and in guiding their search for material. It can be carried out in an ungraded school but it is more likely to succeed in a graded school with pupils on approximately the same level participating. An example of a panel discussion on trees, and the method of organizing it and carrying it on, is given below.

THE PANEL DISCUSSION TO INTRODUCE A NEW TOPIC

STUDY OF TREES, GRADES 7 and 8

As an introduction make pupils acquainted with the trees on the school grounds, along the roadside and in a near-by woods. This direct experience should stimulate interest and enable them to recognize a few common trees by their leaf, fruit, trunk, characteristic branching, and to learn some of their uses. Follow this by an assignment to a panel of three or four pupils who are to prepare a discussion on trees dealing with the unit in the course of study.

1. **Preparation:** Place the divisions of the unit on the board as it is in the Programme of Studies, namely:

Deciduous and evergreen trees.
Use and care of trees on the farm.
Care of a woodlot.
Prevention of forest fires.

Then explain how to prepare and carry out the discussion. Provide suitable reading material on the unit. The chosen pupils should read and plan and write their speeches co-operatively under the supervision and guidance of the teacher. At least one rehearsal in the presence of the teacher is needed to improve the manner and effectiveness of the presentation.

Write a few well-planned questions on the board which are based on the matter under discussion, such as:

1. Give two ways of distinguishing between deciduous and evergreen trees. Name four of each kind and state one identification feature for each tree named.
2. Explain the importance of trees.
3. What should the farmer do to care for his woodlot?
4. How does the government of Ontario try to prevent the outbreak and spread of forest fires?

Direct the class to read these with the purpose of answering them after hearing the discussion.

2. Presentation: When the time for the presentation comes,the members of the group place themselves around a table or the teacher's desk, before the listeners, and fluently, clearly and without interruption, carry on the discussion either by reading their speeches or by speaking from memory.

Notebook Assignment: After the class hears the discussion, direct the pupils to copy in their notebooks from the blackboard each of the questions, and to write the answers in their own words. Supervise and check the correctness and completeness of the answers.

THE PANEL DISCUSSION

DAVID: Our purpose in this discussion is to help you to get better acquainted with trees and their use and care. To me trees are the most interesting of all plants. They are usually so huge and stately that many people fail to see them. I guess it is because most of us look down instead of up. As I look up to see trees, I realize what Stephen Thayer, the poet, said about these magnificent plants:

"Uprightness—standing for truth like a tower;
Dignity—symbol of honour and power;
Beauty that blooms in the ultimate flower.

JEAN: I, too, am interested in trees and like to learn how to call them by name. When I go for a walk I see deciduous trees such as the various species of Maples, Oaks and Poplars, and the Beech, and evergreen trees such as ths Hemlock and the Balsam or the different Pines and Spruces. Deciduous treee have broad leaves which fall in the autumn and then they look bare all winter; evergreens have needle-like leaves which they keep all through the year and which have a dark green appearance. They also bear cones containing seeds. We use evergreens for Christmas trees because they have a graceful cone-like shape and lovely green leaves. My choice is the balsam fir, which appears to have been the original Christmas tree. Its sprays and leaves are flat and dark green above and silvery beneath.

Agnes, can you tell us about other uses of trees?

AGNES: I am pleased to do that. Some of our softwood trees such as the spruce and poplar are valuable for making wood pulp. The paper I am reading from is made from wood pulp. So are our newspapers, books and paper boxes. Cedar and pine trees also have soft wood which makes excellent shingles, boxes and boats. From the balsam fir, that Jean mentioned, we get Canada balsam. It comes from blisters on the bark. Our best hardwood trees are the sugar and black maples, the beech, oaks, hickories and elms. They all make excellent fuel when dry. Moreover, most of them make high-class lumber for flooring and furniture. Hickory wood is very hard, tough and strong so it is excellent for tool handles and for agricultural implements.

But some of our trees have other uses. David, you sometimes go out in the fall looking for hickory nuts. Perhaps you can tell us about nut-bearing trees.

DAVID: Yes, I know something about our nut-bearing trees. Among them are the Beech, Black Walnut, Shagbark Hickory and Butternut trees. They are easy to grow and yield delicious nuts for food. I have gathered many beechnuts and black walnuts and know the trees well. We should grow more of these trees and gather and store their nuts for winter eating.

In discussing the use of trees, Agnes failed to tell the value of trees as ornaments and shelter, and for the conservation of water.

AGNES: Let me turn to those uses now. Nearly everyone plants trees of their choice around the home to make the surroundings attractive. Many farmers also plant Poplars, Spruces and Pines to protect their homes from strong winds and to prevent the top soil of sandy fields from being blown away. Of course farm stock also enjoy the shade of trees during the hot summer days.

Moreover, because most of our forests have been cut down there are serious spring floods in some parts of our province. These can be largely prevented by planting waste land with trees because forest lands hold water like a sponge and let it escape gradually instead of with a rush. We also need woodlots and forests to conserve water for our wells so that they may not go dry in midsummer.

JEAN: Those are all important values you have explained. Along some of our highways I have noticed the sign—Demonstration Woodlot. What does that mean, David?

DAVID: Oh, these woodlots are to show farmers how to care for their own bush. The Forestry Department of Ontario inspect these and the farmers do not have to pay taxes on this land, so long as they do not exceed ten per cent of the area of the farm.

The farmer promises to keep his demonstration woodlot fenced so livestock cannot get in to bite off the leaves and twigs and break down young trees. He clears up all brush and rubbish from time to time to avoid loss by fire, which is often caused by careless smokers and campers. He cuts out all crooked and diseased trees for fuel, and also the mature ones for wood and lumber. Indeed, he aims to keep all vacant places in the bush planted with young trees and protects them so that they may grow into useful timber. I want to say, too, that many of our bird friends frequent these woodlots and greatly help the farmer to check insect pests of trees.

How are the forests of Northern Ontario protected? Can you tell us, Jean?

JEAN: To protect the forests of New Ontario from fires, our provincial government appoints fire rangers to patrol the forests during the summer. There are places in the forest where high steel towers have been erected to serve as lookouts for the rangers. If they see smoke arising, they go to the place as fast as they can to put out the fire. Here is a large picture showing the destruction caused by a forest fire. (Show picture.)

DAVID: I hope we have now given our listeners a better understanding and appreciation of trees. Learn to know them better. Plant more of them and protect them for enjoyment and use.

Now, if there are any questions we shall try to answer them for you.

The panel discussion affords excellent training for pupils where it is well managed by the teacher. Those who prepare the discussion have a real purpose and must read and understand to organize their speeches. There is always the spirit of co-operation and excellent training in composition, spelling, pronunciation and enunciation.

Throughout the preparation the teacher needs to guide and check the efforts of the pupils, but if this is overdone, most of the training value for the pupils is lost. The teacher should not write the speeches, but correct them for rewriting.

THE PANEL DISCUSSION FOR PURPOSES OF REVIEW

PLANTING AND CARE OF TREES AND SHRUBS

JACK: Let us review some of the activities of planting and caring for trees and shrubs. To obtain the most from them for beautification, inspiration and economic values, trees must be properly planted, pruned and protected. Ann, will you discuss planting?

ANN: Yes, I can explain how to plant trees and shrubs. The planting may be done in the fall or early spring. Fall planting has some advantage, for then the roots can become established in the ground for early spring growth.

Let me point out that when a tree or shrub is taken up for transplanting, care should be taken to injure the roots as little as possible. Then the root system should be wrapped in burlap unless the planting is to be done immediately. Nursery men, of course, exercise this care. Roots exposed to the sun or drying air longer than 10–15 minutes do not function properly when set into the soil.

In planting deciduous trees, or shrubs, make the hole a little wider and deeper than the root system so that it can be planted without bending the roots and also a little deeper than it grew in the nursery. When making the hole, put the top soil in one pile and the subsoil in another. Loosen up the subsoil in the bottom and put in some fine top soil on which to set the roots. Examine the roots for injuries. If any are found, cut them off with a sharp knife just back of the injury. This prevents decay and stimulates healthy growth of rootlets.

Set the plant in the hole with the heaviest branching to the north, for usually most growth takes place on the south side facing the sun. Spread out the roots naturally and hold the tree or shrub firmly, and carefully put the fine top soil well around the roots. Press it down to leave no air pockets. If the soil is somewhat dry, or if the planting is done in the spring at the opening of the growing season, pour in a pail of water and let it settle before filling in the subsoil on top. This helps to bring the soil well into contact with the root hairs and dissolves mineral matter for them to take in. If a tree or shrub is dormant, no water is needed. Remember, too, not to pack the subsoil on top, for growing roots need to breathe.

Now prune to form a balanced head and to compensate for the reduction of the root system. With young trees leave only a few well-placed lateral branches and head these back a little, but do not cut back the leader.

JACK: That is very good, but I do not think it all applies to evergreens.

ANN: No, it does not all apply. Evergreens are dug up to form a ball of the soil and root system and then the ball is wrapped in burlap to hold it together. Do not remove the burlap when planting, but loosen it around the top so that none is projecting above the ground after the soil is filled in. Moreover, do not tramp on the ball to break it and injure the fibrous roots. Do no pruning, but water well.

After spring planting it is well to water all trees and shrubs thoroughly every other day to give them a good start, and also keep the surface soil around them mulched to prevent excessive evaporation.

JACK: Now we seem to have the planting pretty well explained. I have noticed that some people give young trees protection.

RUTH: Yes, they do, especially fruit trees. It is well to whitewash young plum and apple trees in the fall to prevent sunscald or bark-splitting during the winter. The whitewash reflects the sun's rays, preventing over-heating in winter when the scald takes place. A strip of building paper tied to the south and west side of the trunk may serve the same purpose. It is also a good idea to support young trees with a stake so high winds may not loosen them, and to insure straight growth. Where rabbits and mice abound, the young fruit tree should be protected against them by a wire cage 2–2½ feet high put around the base, or the trunk may be painted with a repellent such as "sta-off." That, I think, is about all I can say.

JACK: I have seen *suckers* or leafy shoots growing up from underground parts of some trees and shrubs and also *water-sprouts* growing from trunks and branches. Are they harmful?

RUTH: I can answer that too. They are outgrowths from buds due to over-pruning. If the root system is much too large after severe pruning, suckers may shoot up from it, or water sprouts may grow from the trunk or branches. These should all be removed as promptly as possible. To check these outgrowths, prune the roots by thrusting a sharp spade vertically into the soil here and there around the tree or shrub to cut some of the smaller roots. Plum, cherry, silver poplar trees and blackberry, raspberry and lilac bushes need careful management in this respect to prevent suckering.

ANN: Yes, and rose bushes too. They frequently develop suckers from the wild root on which the top is grafted. These should be removed by scraping away a little of the soil so that they can be cut off close to the root without injuring it. The suckers reduce the vigour and blooming power of the rose bush.

JACK: I think we should discuss more fully why established trees and shrubs need pruning. We heard that some pruning may be necessary at the time of planting to offset the loss of roots and to train up a balanced top; and also that suckers should be removed. Is there anything further to say about pruning?

ANN: Pruning indeed, is a very important factor for keeping trees and shrubs looking attractive and healthy, in lawns, parks and gardens. In the wood we find that nature prunes the trees and does a fairly good job for timber, but for ornamental purposes in parks, streets and gardens we need to assist her to produce the shape we want.

In pruning we remove water-sprouts because they spoil the form of the tree and retard desirable growth. We cut out decaying and diseased branches in order to prevent the disease from spreading to other branches. We remove branches which may form crotches that will cause the tree to split later.

Street trees frequently need pruning so they will not interfere with the traffic of vehicles and man. Commonly it is desired to train the heads of trees to have a high branching effect which will reach part way over the street. What is grander than two fine rows of elm trees forming an archway over a street?

In case of fruit trees a chief purpose of pruning is to produce better quality and more abundant fruit and to keep the tops within easy reach of the pickers.

All this means that pruners need to understand the nature of the tree or the shrub and the purpose for which it is wanted.

Now, perhaps Jack has further ideas about pruning.

Jack: Yes, I have. Some people prune at any time. This is not good except to remove diseased branches and water-sprouts. Dr. Rush Marshall, who studied this activity for years, found that February is the best time to prune trees. At that time the removal of diseased branches will not cause the spores of the disease to spread to other branches. The wood is also dormant, which is the right condition for dressing the wounds to block the wood vessels. To do this it has been found that a coating of asphalt varnish gives the best protection. The early spring growth of the cambium layer under the bark forms a callus and quickly heals the wound. Summer pruning retards healing and fall and early winter pruning delays the healing too long. Of course fruit and rose bushes will have to wait until the snow is off the ground; but prune them before the buds begin to swell.

Ann: Those are important facts to put into practice, but I would like to have the audience hear a few rules on how to prune.

Jacj: Well, suppose you give us a summary of the rules.

Ann: Thank you! Here they are.

Things to do in pruning trees:

1. Use sharp tools.
2. Cut the branch as close to the crotch as possible leaving no stub. Stubs soon decay, for the wound does not heal over and the disease spreads to other branches.
3. In cutting large branches avoid splitting the wood and skinning the bark by first making a temporary cut on the lower side of the branch about a foot from the crotch until the saw binds. Then cut down through from above as close to the crotch as possible and parallel to the trunk or large branch.
4. Do not butcher the tree by pruning out too much in any one season. Neglected trees can usually not be brought into shape in one year.
5. Cut out all small crossing or interfering branches.
6. As a general rule do not head back the leading branch of the tree.
7. On deciduous trees always apply a dressing to the wounds such as asphalt emulsion, grafting wax, or coal tar.
8. In case of evergreens only cut off any of the bottom branches which are dead. Any side branches which are getting too long should have the tips pinched off.

These principles do not all apply to shrubs. Perhaps Ruth can briefly discuss the pruning of shrubs.

Ruth: I am pleased to point out a few factors in pruning shrubs. They renew themselves by growing new shoots from the base of the plant, while trees produce the new wood near the top. Consequently shrubs need different pruning from that of trees.

In the main, shrubs are pruned to renew the wood from the base. This is done by cutting out the oldest branches every year or two from all sides, leaving the bush in a pleasing shape. Then the young wood will grow into natural outlines and produce a profusion of bloom.

Shrubs which bloom in the spring and early summer, such as Forsythia, Spiraea, Van Houttei (Bridal Wreath), Flowering Almond and Lilac, are best pruned immediately after they have flowered. Spring pruning of these would mean the removal of hundreds of flower buds that would open later.

Shrubs which bloom during late summer and autumn, such as Hydrangeas, Barberry, Kerria and Privet, should be pruned in winter or early spring for they produce their flowers on young wood developed the same year.

Remember not to shear shrubs but to reach in from all sides and cut out old branches to give the shrubs balance. If this is not done, shrubs year after year become more and more choked with old stems that shut out the light so young shoots will not grow. Sometimes when shrubs become old and unsightly cut them back to the soil and they will usually rejuvenate themselves.

JACK: You did very well. And this is all we have for our listeners today. We hope we made our discussion clear and that you enjoyed it.

PUBLICATIONS TO HELP YOU

Improvement of Rural School Grounds—Circular 56G
Ontario Department of Education, Toronto

Trees for Schools
Department of Lands and Forests, Toronto

Pruning Fruit Trees—Bulletin 392
Ontario Department of Agriculture, Toronto

APPENDIX B

APPARATUS AND MATERIALS

The following list of equipment should be in every Public and Separate School where agriculture is undertaken and may be secured locally or from any firm dealing in laboratory apparatus. Expenditure for this purpose will be allowed as a part of the agricultural grant.

4 glass beakers, 400 c.c.
2 glass funnels, 60 to 80 mm. dia.
1 doz. or more test tubes, 6″ x ¾″.
1 test tube rack and brush.
2 evaporating dishes, 75 mm. dia.
2 lamp chimneys.
I measuring cylinder (graduate) 100 c.c.
1 chemical thermometer (Fahrenheit).
Egg-candling appliances.
Reactosoil tester.
1 common double boiler.
Supply of wood alcohol.
1 alcohol lamp or an electric hot plate.
1 tripod lens for every two pupils.
Red and blue litmus paper and filter paper.
Rennet tablets
Nitric acid
Hydrochloric acid
Slaked lime (calcium hydroxide).
Samples of fertilizers.
Samples of types of soil.
Samples of insecticides.
Samples of fungicides.
Samples of grit and oyster-shell.
Samples of fine, medium and coarse wool.
Grafting wax.
Half-dozen paring knives.
6 glass fruit jars, quart size.
1 doz. each of soup plates and saucers.
A supply of 4″ flower pots.
Shallow boxes for planting seeds.
An insect killing bottle and spreading board.
An insect cage or vivarium.
One hand sprayer.

Selection of equipment should be made by the teacher, year by year, to meet the requirements of the course or courses taken.

INDEX

- Acidity, soil 22
- Agriculture, importance of 5
  - improvements in modern 5
- Air in soil 14, 24
- Albumin 60
- Ammonia 24
- Ammonium sulphate 21
- Animals in soil formation 13
- Animals, live stock 41
- Apparatus, list of 133

- Babcock test 63
- Bacteria, denitrifying 23
  - in soil 23, 119
  - in soil formation 13
  - nitrifying 23
  - nitrogen-fixing 20, 23
- Beef cattle 44
- Benedict's solution 60
- Bird houses 113
- Birds, conservation of 110
  - feeding habits of 111
  - protection of 112
- Blackberries 106
- Black knot 120
- Border, perennial 101
- Bouquets 103
- Brooding 79
- Budding 30
- Bulbs, indoor care of 99
  - in water 100
  - outdoor planting of 100
  - structure of 99, 101
- Bush fruits 104, 106
- Butter-fat 59

- Calcium 17, 61
- Cambium layer 30
- Carbon dioxide 13
- Care of milk 66
- Casein 60
- Cattle, beef 44
  - dairy 41
  - dual-purpose 45
  - grade 45
  - pedigreed 45
  - pure bred 45
  - scrub 45
- Cheese 60
- Cleft grafting 30
- Cold frame, care 97
  - construction 97
  - transplanting 97
- Contamination of milk 66
- Corn smut 122
- Crop rotation 22, 119, 122
- Currants 106
- Cuttings 29

- Dairy cattle 41
- Dairy industry 54
- Discussion panel 126
- Diseases of plants 117
- Drainage 17
- Dual-purpose cattle 45

- Eggs, candling 77
  - grades 76
  - incubation 77
  - storage 86
  - structure 75
- Erosion 12, 22

- Fat, grease-spot test 59
  - percentage in milk 61
  - testing for 59
- Feeding poultry 79, 86
- Fehling's solution 60
- Fertilizers, complete 21
  - nitrate 21
  - phosphate 21
  - potash 21
- Flats, indoor 97
- Fruits, bush 104
- Fruit trees, selection 105
  - planting 105
  - care 106
  - panel discussion 129
- Fungus diseases 117

- Gardening 93
- Garden, layout 94
  - planting 94
  - seed selection 94
  - site 93
  - soil preparation 94
- Germination, tests 32
  - times for 32
- Glaciers 11
- Gooseberries 106
- Grading eggs 76
- Grafting 30

- Hardwood cuttings 30
- Hogs 48
- Horses 46
- Hotbed, care 96
  - construction 95
  - planting 96
- Housing poultry 81
- Humus 10
- Hydration 13

- Incubation 77
- Indoor flats 97
- Insects, control by birds 110

- Layering 30
- Legumes 20
- Lime 22
- Litmus test 22
- Live stock 41

- Magnesia 23
- Manure, animal 19
  - green 19
- Materials, list of 133
- Milk, bacteria in 65
  - care of 66
  - composition 59, 61
  - contamination of 66

INDEX *(Continued)*

  fat 59
  pasteurization of 65
  sugar 60
Muck 9
Mulching 96, 106, 107, 108

Nitrogen 17
Nitrogen-fixing bacteria 20, 23
Nodules 20

Organic matter in soil 9, 19
Oxidation 13

Panel discussion 126
Pasteurization 65
Perennials 101
Perennial border, care 101
  planting 102
  plants for 102
  soil 101
Phosphorus 17, 61
Phosphoric acid 17
Pie plant 108
Pigs 48
Plant diseases 117
Plants in soil formation 13
Plant propagation, by bulbs 29
  cleft grafting 30
  cuttings or slips 29
  hardwood cuttings 30
  layering 30
  seeds 29
  shield budding 30
  sprouts or suckers 29
Plate method 32
Potash 17
Potassium 17
Potassium chloride 21
Potassium sulphate 21
Potato scab 119
Poultry, classification 72
  common breeds 72
  feeding 79, 86
  housing 81
  keeping 77
  prevention of lice on 86
Protein 60
Pruning 106

Ragdoll method 32
Raspberries 106
Replanting 94
Rhubarb, winter forcing 108
Rotation of crops 22, 119, 122
Runners 29
Rust, wheat 123

Scab, apple 117
  potato 119
Scions 30
Seed, development 29
  germination 32
  germination times 32
  standard weights 32
  testing 31
Sheep, fine wool 52
  long wool 51
  medium wool 51
  mutton type 51
Shield budding 30
Slips 29
Smut, corn 122
Sodium nitrate 21
Soil, acidity 22
  bacteria in 23, 119
  depth 11
  erosion 12, 22
  fertility 17
  forming agents 11
  garden 9
  heavy and light 10
  particles 9
  profile 11
  sedentary 13
  testing 22
  transported 13
  types 10
Spraying 106, 118
Sprouts 29
Stem rust of wheat 123
Storage, vegetables 109
Strawberries 107
Subsoil 11
Suckers 29
Superphosphate 21

Temperature in soil formation 12
Thinning 96, 98
Top-grafting 31
Transplanting 95, 97, 105, 107
Trees, fruit 104
  panel discussion 127

Vegetables, harvesting 109
  storing 109
Vitamins 61, 75

Water, capillary 16
  film 14
  free 14
  gravitational 14
  in soil 14, 17
  in soil formation 12
Weeds, annual and biennial 33
  collection of 33
  control of 37
  injurious 34
  noxious 36
  perennial 38
Weed killers 38
Weed seeds 34
Wheat rust 123
Wind in soil formation 12
Winter storage 109